POWER OPERATOR'S GUIDE

{1001 PRACTICAL HELPS}

A COMPILATION OF IDEAS, METHODS, AND
TOOLS FOR SAVING TIME, LABOR, AND MONEY
IN THE POWER PLANT AND ALONG THE LINE
OF POWER SERVICES

COMPILED AND EDITED BY
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FIRST EDITION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK AND LONDON
1935

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THE MAPLE PRESS COMPANY, YORK, PA.

PREFACE

Ingenuity is the outstanding characteristic of power-operating men and master mechanics, because out of their daily experience in handling machinery and forestalling or overcoming emergencies they are constantly evolving original ways of doing things—short cuts and time- and labor-saving ideas that deserve to be passed along to other operating men.

Power has for years recorded these helps—call them ideas, kinks, schemes, pointers, or what you will. That department, called at various times "Ideas from Practical Men," "Right Out of the Plant," and, more recently, "Practical Aids to Operation," has for years been one of the most popular portions of the magazine. We on *Power* select and prepare these items carefully, for we believe that engineers in every power plant can find among them dozens of ideas that will save grief and worry and enable those engineers to handle repairs, maintenance, and specialized problems more quickly and economically than might otherwise be possible.

Our aim is to publish in each number of *Power* a dozen or more diversified ideas, so that as many men may be benefited as possible. This precludes any classification of items, so that the reader who wishes to sort ideas by subject is faced with a tedious and almost impossible task. Thus, he files complete copies of the magazine, with the result that specific items are not readily available in emergency. This has created a definite need for a classified compilation of these helps and ideas in readily usable form. One or two collections of a hundred or so items have been made, but this is the first really comprehensive compendium of practical aids to meet the needs of the power operator. The compiler has gone through all copies of *Power* for the years 1928 to 1934, selecting and editing 1001 of the best ideas which have been printed during that period, and classifying them by subject into 19 chapters.

Naturally, the longest chapters have to do with steam and power generation, but there are also hundreds of items on oil and gas engines, building services, pumps, and kindred subjects—everything from how to repair a pump gland to how to set up a suitable shift system in the plant.

In presenting these helps, the compiler wishes to extend full credit to the skill and ingenuity of the hundreds of able men who orginated them and were considerate enough to pass them along for the benefit of others. Here is a further culling of the best thinking and planning from the originally carefully selected group of items which have appeared in the magazine. In order to present as many as possible within the given space limitations, it has been necessary to cut out portions of letters not having to do with the problem or not vitally necessary in its explanation.

The compiler wishes to acknowledge the assistance and advice of his associates on *Power;* the kindness of E. A. Earle and F. P. MacNeil, each of whom provided a set of numbers of the magazine so that this compilation was possible; and the unstinting aid of the compiler's wife, Mary Christopher Tangerman, who undertook the laborious task of clipping and pasting items and arranging manuscript.

E. J. TANGERMAN.

NEW YORK, N.Y.
June, 1935

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POWER OPERATOR'S GUIDE

CHAPTER I

FUELS, FIRING, FURNACES, AND COMBUSTION

1-5. Five Hints in Storing Bituminous Coal.

1. Loss in heat content through disintegration has been found to be as high as 10 per cent where coal has stood in the open without overhauling for long periods of time. The chemical action that takes place may be described in two distinct steps. First, the pyrites and other inorganics unite with oxygen. Second, the organic matter of the coal oxidizes. The first may cause an increase in volume with a corresponding decrease in weight per cubic foot or a so-called swelling of the coal. The oxidization of the organic matter involves gradual chemical combustion of carbon, hydrogen, and hydrocarbons.

2. Probably restricted ventilation is the cause of practically all fires in coal piles. Coarse, dry, lumpy coal naturally ventilates itself and requires little or no handling over long periods of time. But with a very fine coal, especially if stored damp, one may be suspicious of possible trouble. Such conditions favor the complete blocking of necessary ventilation, especially if stored in a deep pile.

3. The greatest practical depth of coal storage depends on the condition of the coal and the length of time it is to remain untouched. It also, of course, depends on the available head room and the type of coal-handling equipment. As a general rule, a maximum of 6 to 8 ft. for very fine coal, 8 to 10 ft. for average fine coal, and up to 15 ft. for coarser coal with lumps may be suggested. These averages are for conditions where the coal is to lie idle for as long as a year at a time.

4. Probably one of the best methods of detecting undue heating of the coal pile is with thermocouples. A convenient arrangement consists of a thermocouple unit inserted in a 10- or

12-ft. length of pointed ½-in. pipe. A standard galvanometer temperature indicator is connected from the leads at the end of the pipe. The pipe is pushed down into the coal pile in various places for several minutes at a time to take temperature readings. Should a place be found showing a temperature of over 140°F., it should be marked and checked each day to see if it continues to rise. If such is the case, this place should be taken care of.

5. Once a fire starts, two things must be accomplished as quickly as possible. The center of the fire must be reached, and the outside limits determined to stop its spreading. A pointed length of 2½-in. pipe with a number of ½-in. holes drilled in it may be screwed to the end of a fire hose. The pipe may be forced down at the center of the fire where water will be the most effective. In large-area, low-level coal piles, the burning section should be isolated by digging around the circumference of the fire limits, and care should be taken not to shift any of the hot coal on to other sections of the pile.

Waterville, Maine. HARRY M. SPRING.

6. Extinguishing Fires in Coal Piles.

My first experience with a coal-pile fire showed me that throwing water on the pile had little effect. The water must be forced directly into the fire, instead of being baffled away by a volume of vapor and gas that develops when the water trickles into the heated zone from the outside.

We took a piece of 2½-in. pipe, 12 ft. long, pointed it at one end, and screwed a T on the other. A capped nipple was screwed into the other end of the T, and the side outlet served as a hose connection. The pipe was slotted from the point for about 5 ft. The slots were made ⅛ in. wide and about 6 in. long. Short bridges of metal were left between them to give strength and hold the shape of the pipe. When the coal was found gassing or burning, this pipe was forced through the pile into the fire, the hose connected, and water turned on. With this device we have stopped gassing of coal piles and put out fires in a short time with little water.

It is some time since we have had trouble with coal-pile fires. The reason for this is we buy coal that can be safely stored. It is piled on concrete platforms along our switch tracks. If a car of dirty coal comes in, we use it at once or place it where it can be moved readily with the crane.

Elgin, Ill. W. L. Parker.

7. Tempering Slack Coal.

Every engineer who has had to burn slack coal on a chain-grate stoker knows how hard it is to keep an even fire if the coal is dry.

We have an overhead coal bunker that holds about four days' supply. Coal is elevated into it with a bucket elevator that discharges through a spout. We installed an ordinary lawn-spray nozzle in the end of the spout so that the water plays over the entire stream of coal and cone beneath. It took a little practice on the part of the coal man to get just the right amount of water, but when this is set the mixture is the same as long as the elevator is kept running at its full capacity.

This system works much better than trying to wet the coal in the weigh larry or in the stoker hopper, because it is more uniform. The fact that the coal stands from one to four days allows any excess moisture to seep away. Being drawn from the bottom of the bin, the coal is continually agitated, and there is no chance of its heating and causing spontaneous combustion.

Butte, Mont. A. D. Ford.

8. Handling Low-volatile Fines.

From past experiences in burning low-volatile coal on type-E stokers, weighing the coke "carry over" taken from the combustion chambers and checking the coke fines as taken from the stack base, I have arrived at 4 per cent as a conservative figure for the B.t.u. loss from the use of a 14600-B.t.u. coal.

Amherst, Mass. H. Bidwell,
Chief Engineer, Massachuetts Agricultural College.

9. Marking Controller Points Simplifies Coal-pulverizer Operation.

We have two large pulverized-coal fired boilers, each fed by two unit-type pulverizers. The pulverizers are direct driven by large alternating-current motors and are constant speed. To vary output, each machine is equipped with a 1-hp. variable-speed direct-current motor connected to a rotary feeder supplying the pulverizer hopper. The direct-current motor controllers use resistance in the armature circuit to start and resistance in the field circuit to regulate motor speed after it reaches minimum speed of about 900 r.p.m. To assist the fireman in dividing the load equally between burners, each field point has been numbered in yellow enamel, beginning with one as the lowest speed. We have found the open-type controller more desirable than the closed type because its position is easily seen, whereas it is mostly guesswork with the closed type.

Nashville, Tenn. T. E. Miller.

10. Concrete Jams Magnetic Separator.

The plant was equipped with a unit system of pulverizers. A piece of concrete about 2 in. square either passed through the coal crusher or dropped into the coal bunker and then passed through the feeder until it started to pass the magnetic drum. Here it wedged between one end of the drum and the cast-iron casing and caused the speed-change gears to jump out into neutral, thus preventing any further damage.

After the concrete was removed and the coal-feeding mechanism started, the chain driving the magnetic drum broke, and it was impossible to turn the drum by hand when it should revolve easily. It had been forced endways on the shaft until its end face was binding on the housing. The drum was recentered on its shaft, and a bronze collar put at each end between housing and drum to prevent the drum from being pushed along the shaft again.

Milford, N. J. Harry M. Spring.

11. Improved Bushing for Stoker Pinion.

In stokers using planetary gears, we experienced trouble with a shaft on which one pinion turned. The two pinions were formed on one blank and ran in mesh with the outside ring gears. The shaft on which they turned was originally of brass and was pinned to the housing so that the pinion ran on a stationary shaft, which consequently wore on one side only. This wear allowed the pinion to back out of proper mesh, causing the teeth to break.

We tried additional oil grooves and harder pins, but the method that proved most successful was the following: A pin was turned up out of steel and casehardened. We then took the pinion and turned enough out of the bore to allow a bushing to be fitted which would be a running fit on the pin. This we also made up and casehardened, drilling oil holes and grooves so that adequate lubrication was assured.

Port Arthur, Ont. R. G. EDWARDS.

12. Feeder Layout Prevents Shutdowns.

In a Texas cement mine, the two water-tube boilers are equipped with pulverized-coal burners. Coal is ground at the cement kilns, then is conveyed to the boiler hoppers through a pipe about 600 ft. long. Each boiler has a separate bin, feed screw, and air blower.

To permit either of the two boilers to be kept in service even though its own feeder is clogged or its blower is out of commission, the engineer has arranged the connections so that the feeder and air duct of boiler 1 can be connected to the burner of boiler 2.

El Paso, Tex. DONALD McFEE.

13. Air Hose Should Be Grounded.

One of our screen-type coal-pulverizing mills was to be opened for its periodic inspection. I had found from experience that when the inside was thoroughly cleaned with the air hose, there was practically no dust caused around the plant when the casing and screens were removed. To do this cleaning, we use 80-lb. air on a 1-in. heavy rubber hose bushed at the outlet to take a 3-ft. piece of ¼-in. pipe. When the hose is inserted through the 10-in. manhole in the top of the mill and a strong flashlight is used, this combination does a good job.

Recently, when I was blowing out the mill, the first few minutes the dust was pretty thick, and it was during this period that the 3-ft. nipple, free from metallic contact at its upper end, was swung fairly close to the protecting screen, and an arc was formed

Although the expected explosion did not occur, I quit blowing immediately and decided to provide a safeguard before proceeding further with the cleaning. I soldered a loop to the brass hose connection and attached a length of light chain to it and to a spring clamp on the other end of the hose, which was fastened to a good ground.

Sanford, Maine. E. S. WOODWARD.

14. Air Ejector for Chain-grate Siftings.

We experienced a good deal of trouble in removing fine coal and dust from the wind boxes of our chain-grate stokers. We finally equipped all wind boxes with air ejectors, as in Fig. 1. Now all that is necessary to clean the boxes is to remove the cover and open the air valve, and the boxes are blown clean in a few minutes.

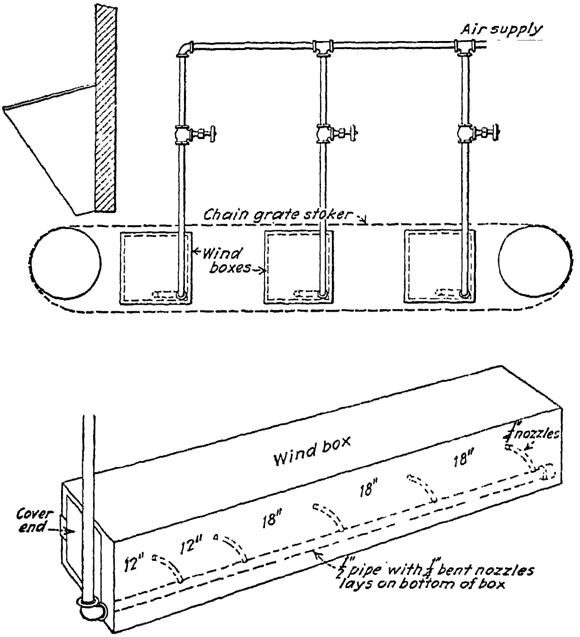

FIG. 1.—Arrangement of air-ejector nozzles in wind box.

Wilkes-Barre, Pa. THOMAS M. STREET.

15. Recirculation Connection Improves Coal Pulverization.

When passing from the pulverizer to the burners, the heavier particles of coal would settle to the bottom of the duct, causing the coarse coal to dribble out at the bottom of the burner. This coal caked on the furnace wall under the burner, overheated the burner, and damaged the refractory surface.

Overhauling of the pulverizer, together with careful adjustment of air supply, failed to correct the trouble. It was then decided to run a 1½-in. pipe line from the under side of the burner duct back to the intake end of the pulverizer, as in Fig. 2. Heavier particles of coal flowing along the bottom of the duct drop into this line and return to the pulverizer. A gate valve is provided in this line to regulate the amount of coal returned. This arrangement has proved satisfactory.

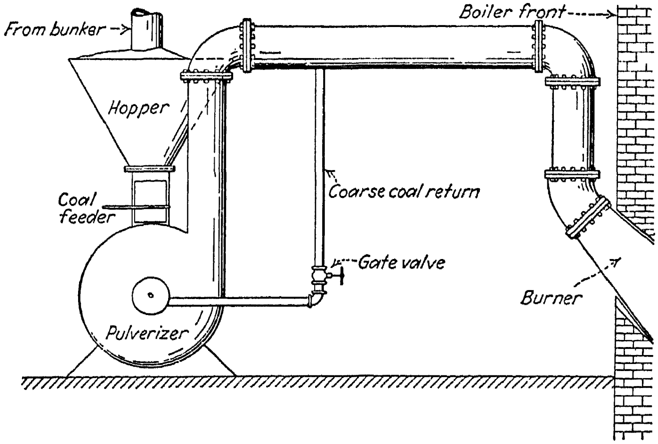

Fig. 2.—One and one-half-inch pipe line used for recirculation connection.

Milford, N. J. Harry M. Spring.

16. No-coal Alarm for Pulverized-coal Feeder.

Pulverized-coal unit-fired boiler plants require a continuous flow of coal from the bunkers. By providing a no-coal alarm, warning will be given even before the burners go out.

In Fig. 3, the hopper of a unit coal pulverizer is diagrammed with the necessary attachments for the alarm. All parts are easily made and assembled, the only purchased parts being a low-voltage relay and bell. Two pieces of strap iron are welded together as shown and form the lever arm, which is supported in two bearings. A small hopper is constructed from sheet steel. It has no bottom and is suspended from the end of the lever arm.

As long as the coal is above the auxiliary hopper or flowing through it, the lever arm will be held on the stop bracket and against the tension of the spring. If for any reason the coal supply fails, the spring will pull the lever back as soon as the

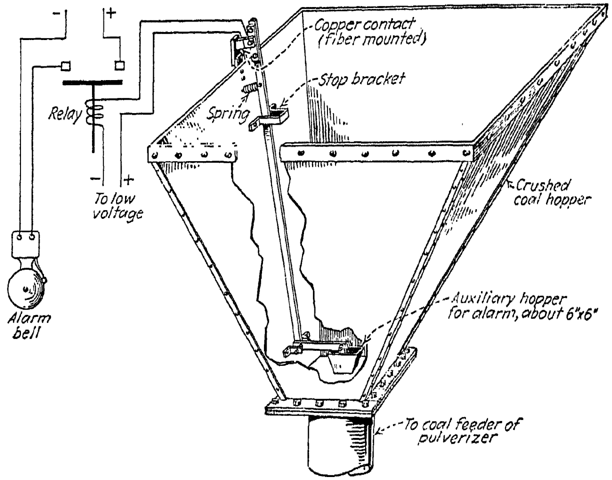
Copper contact (fiber mounted)
Stop bracket
Spring
Relay
To low voltage
Crushed coal hopper
Alarm bell
Auxiliary hopper for alarm, about 6"x6"
To coal feeder of pulverizer

FIG. 3.—No-coal alarm for pulverized-coal feeder.

auxiliary hopper empties and close the circuit through the relay and bell alarm.

Milford, N. J. HARRY M. SPRING.

17. Stoppage and No-coal Alarms Combined.

Figure 4 shows a device which I am now using and which will not tend to clog the hopper. As every operating man knows, even a small stick will cause stoppage in the hopper if the coal is a little damp.

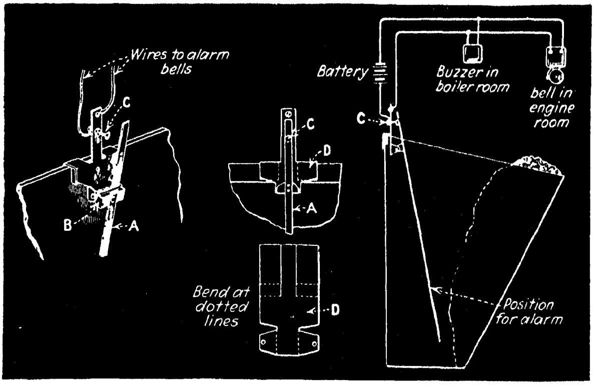

FIG. 4.—Stoppage, or no-coal alarm, for feeder.

The alarm consists of a flat steel arm *A*, ½ in. wide and ⅛ in. thick, of a length about equal to the depth of the hopper. This arm is pivoted at *B* on a bracket *D*, which is cut and bent from a piece of steel 1/16 in. thick, made to slip over the edge of the hopper. A coil spring is slipped over the pivot pin and is bent to make the arm swing out into the hopper and make contact at *C*, which is the insulated contact. For the alarm circuit a buzzer is used in the boiler room, and a bell in the engine room, operated by two dry cells.

When there is coal in the hopper, arm *A* is held against the side of the hopper, and the alarm circuit is open. If the hopper is empty or the coal sticks, the arm swings to the right and closes the alarm circuit. No matter how wet and sticky the coal may be, the hopper always empties on the vertical side, which is just above the feeder opening. If the coal sticks, it is on the sloping side, somewhat similar to the form indicated by the dotted line, and allows the alarm contact to close.

Milwaukee, Wis. L. M. Larson.

18. Improvement to Stoker Hopper Permits Observation of Coal Feed.

Our coal larry operated from a mezzanine floor above the firing floor proper. Stoker hoppers were extended up to this floor, making it difficult to see whether the coal was sticking or arching over the rams. The hopper was fitted with a small door directly over the rams; but if this was opened, a quantity of coal would fall to the floor, and sometimes the door would stick and become difficult to remove.

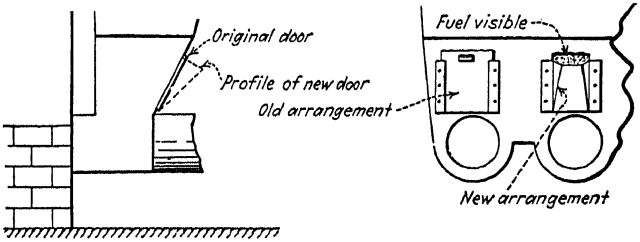

Fig. 5.—Improved door in stoker hopper for ready observation of coal feed.

To overcome this and at the same time do away with the necessity of opening the door at all, we constructed a door as shown in Fig. 5. This not only gives a view of the coal in the hopper, but a piece of pipe can readily be inserted to break up any coal that arches over the rams.

Port Arthur, Ont. R. G. EDWARDS.

19. Feeding Coal to Elevator with Compressed Air.

Figure 6 shows how we got around a difficulty in unloading a very fine dustlike grade of anthracite. This coal would not slide through the opening at the bottom of the coal pit when dumped from the cars and gave us trouble until we rigged up the air pipe as shown. Now we turn on the air, open the car dump, and the coal feeds through to the elevator nicely.

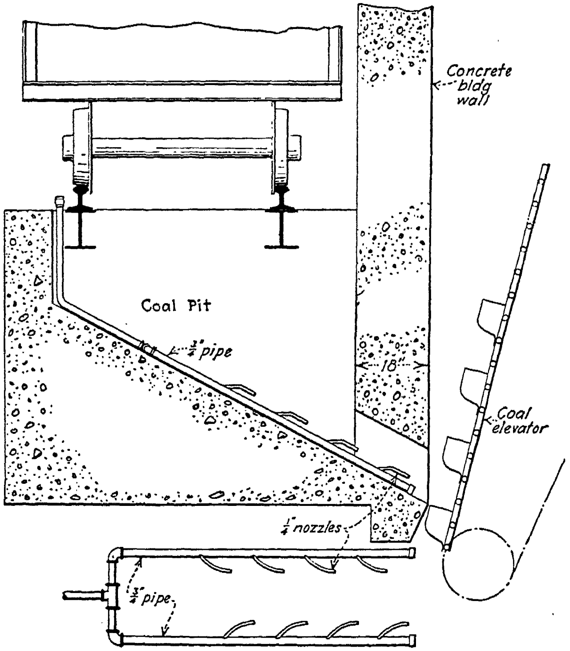

FIG. 6.—Arrangement of compressed-air nozzles in coal-unloading pit.

Wilkes-Barre, Pa. THOMAS M. STREET.

20. A Repair to Steel Coal Bunker.

At the London Hydraulic Power Co., the steel coal storage bunkers began to corrode, and some kind of repair or replacement of the plates became necessary.

As replacing the plates would have meant considerable expense, it was decided to line the bunkers with reinforced concrete, using "Hy Rib" steel lathing to support it. The main steel supports were in good condition, so lathing was fixed to this and to the sound parts of the steel plates. Then the space between the worn plating and the lathing was filled with a concrete made of one part cement and three parts sand, to which was added some long cow hair to act as a binder, 1 lb. of hair being added to 3 cu. ft. of concrete.

When the concrete had set, the outside was plastered smooth to protect the lathing and give a smooth surface exposed to the coal. The cost of this repair was about one-tenth that of replacing the steel plates.

Shefford, England. W. E. Warner.

21. Protecting Steel Plates in Coal Bunker.

Some steel plates in a coal bunker were found worn badly owing to corrosion and abrasion. The plates were first cleaned of scale and deposit by wire brushes, then a wire mesh was spot-welded to the plates. Liquid concrete composed of three parts fine sharp sand, one part Portland cement, and sufficient water to give liquidity was then applied over the mesh by a cement gun. An air pressure of 35 lb. was used on the spray gun, and a coat about 0.5 in. thick was sprayed on. When this was quite dry a second application about 0.1 in. thick was sprayed to give a perfectly smooth coating.

Any type of metal plate can be protected in this way. Where a concrete spraying gun is not available, a less efficient but at the same time less expensive method of protection is to make up a concrete mixture as previously mentioned, but add sufficient water to make it thin enough to be applied by a brush. Two coats of this mixture applied to plates will give them a continuous coating. The concrete coating will have to be renewed from time to time, as the original one wears away, but a fresh coating can be easily applied.

Hertfordshire, England. W. E. Warner.

22. Reduces Pulverized-coal Burner Size to Improve Operation.

In an industrial power plant, the boilers were fired by a unit pulverized-coal system, using plain venturi-type burners. The boilers operated with an efficiency of about 70 per cent and 10 per cent CO_2. These values could be considerably improved by reducing the excess air, but when this was done the burners were destroyed in a short time. In attempting to secure better combustion, three burners were burned up in less than two months in spite of especial care.

Burner specifications were consulted, and it was discovered that they were designed for 600 per cent boiler rating. The average boiler rating in this case was 250 per cent, and at times the load dropped to 150 per cent for several hours at a time. It was known that each time the burners overheated the boilers were on light load. The burners, being of so much greater cross-section area than necessary, had caused too low a coal-air velocity at low loads. With the correct amount of secondary air for the steam flow, the fire would back up into the burners. This would quickly cause coking wherever a slightly roughened spot would give it a start. Installing burners of correct capacity allowed CO_2 to be increased to 13.5 per cent average with a boiler efficiency of 75 to 79 per cent.

Cleveland, Ohio. M. E. WAGNER.

23-25. Three Pointers in Locating Igniter.

The correct location of an oil-burner type igniter for pulverized-fuel furnaces is dependent upon several essential factors: type of igniter and its capacity; type, size, and other characteristics of the burner; location of the burner in the furnace; relative location of the burners (if in multiple) to each other; direction of the fuel streams; size and shape of the combustion chamber; and relative accessibility of igniter and fuel controls. Here are three pointers:

23. For two burners so close together that the igniter flame would contact both fuel streams, one igniter located centrally between, and on the level of, the burners would be sufficient. If a separate igniter for each burner were desired, the proper location would be central with, and just below, the burner; if placed above the burner, the igniter would not be within easy reach. The igniter nozzle should be at such an angle as will insure the flame's striking the fuel stream about 3 to 4 ft. from the mouth of the burner.

24. If more convenient to locate the igniters on the side walls, equally satisfactory results would be obtained by locating them

4 to 5 ft. back from the inside face of the front of the boiler and approximately on the level of the center line of the fuel stream. In this location, one igniter would be sufficient if strong enough to throw a flame to the far fuel stream.

25. Definite location can be decided only by detailed consideration, though with the burner type of igniter, capable of throwing a flame 15 to 20 ft. and reaching any part of the furnace (by multiple installation when necessary), location need not be so precisely determined.

An additional feature of the burner type of igniter, and one of considerable value and utility, is in its ability, by its own power alone, to keep up steam under light load when the pulverized-fuel fire refuses to function satisfactorily; for maintaining line pressure during stand-by periods and to bring the boiler back to line pressure from cold or banked condition; or when with no other power available the pulverized fuel could not be operated.

New York, N. Y. P. RICHARDSON.

26. Pulverized-coal Igniter.

It is evident from P. Richardson's comments upon proper location for ignition torch in pulverized-coal burners that there is a general opinion that ignition torches should be used to carry light loads and for maintaining line pressure and to bring the boiler back to line pressure from a cold or banked condition.

We have a 19,500-sq. ft. boiler with a two-unit mill installation, each mill having a capacity of 15,000 lb. per hour. There are two horizontal turbulent-type burners to each mill. Normal steam pressure is 325 lb. at the boiler and 315 lb. at the turbine throttle.

We have a 30,000-kw. turbine-generator which we run approximately 16 hr. each day. In the shutdown period, the steam pressure on the boiler drops to about 100 lb. According to the previous discusser it would be good practice to bring this boiler up to line pressure with the ignition torches. We find, however, that this is not practical. We can bring the boiler up to line pressure using an average of 2 tons of coal. It takes about 45 min. to do this. The rolling period for the turbine is 1¾ hr.

We find that we can bring the boiler up to the pressure, roll and bring the turbine up to speed, consuming in all about 2½ hr., and use 4.5 tons of coal. To do the same thing with the ignition torches we would have to use around 200 gal. of fuel oil. The cheaper way is obvious.

There is no doubt that a burner type of ignition torch would prove of considerable value, with its ability to keep up steam under light loads when the pulverized-fuel fire refuses to function, if there is only one mill to a boiler. It would be of no use in a two-unit mill installation because if one mill is out of order it is entirely possible to carry light loads or to keep the boiler in a banked condition with the other mill.

Venice, Ill. JOHN G. BRIDER.

27. Interlock for Coal-handling Equipment.

The coal-handling equipment of a certain industrial plant consists of a crusher, an elevator, and a distributing conveyor, as illustrated in Fig. 7. The elevator and conveyor are each operated by a 7.5-hp. motor, while the crusher is driven by a 30-hp. motor. As a shutdown of the conveyor with the crusher and elevator running, or a shutdown of the conveyor and elevator with the crusher running, would tie up the system and cause considerable inconvenience, the interlock system shown was installed.

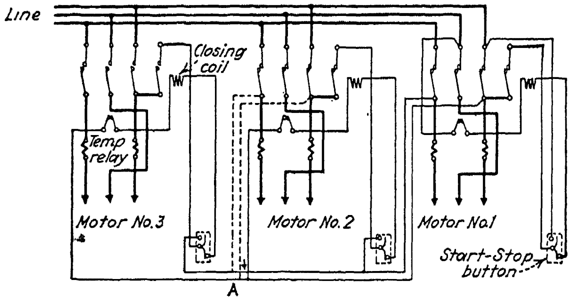

FIG. 7.—Interlock system for coal-handling equipment.

The magnetic switch on the conveyor motor (No. 1) acts as the master switch for the complete equipment, and the elevator and crusher motors (2 and 3) cannot be started until No. 1 is running. Either No. 2 or No. 3 can be stopped by pressing their individual stop buttons, while pressing the stop button on No. 1 shuts down the three motors. If for any reason motor 1 stops, all three stop, and it is impossible to start either No. 2 or No. 3 until No. 1 is again running.

By cutting the control circuit to the start-stop button of motor 3 at the arrows *A* and connecting this control circuit as indicated by the dotted lines, it is impossible to start motor 3 until No. 2 is running and also impossible to start No. 2 until No. 1 is running. This system can be worked on any number of motors. The control equipment can be installed away from all dust and dirt, and the only exposed parts are the push buttons, which can be placed in any convenient position. This system costs considerably less to install than compensators and, since it is foolproof, saves considerable time and inconvenience and possible damage to equipment.

Port Arthur, Ont. J. S. E. Stafford.

28-31. Four Hints for Preventing Plug-ups on Transport Pump.

Occasionally, considerable quantities of wet coal were delivered to fuel-transport pumps. Also, at times, slugs of the accumulation that formed on the inside of the long vent pipes, owing to this moisture condition, would fall into the pump and cause plugging.

28. It is not always possible to rearrange a plant to overcome these difficulties, and when such abnormal conditions prevail, this arrangement of air connections will be found a material help. The upper cover casing and top half of the barrel were removed. At *A* and *B* (Fig. 8), holes were drilled for ½-in. pipe

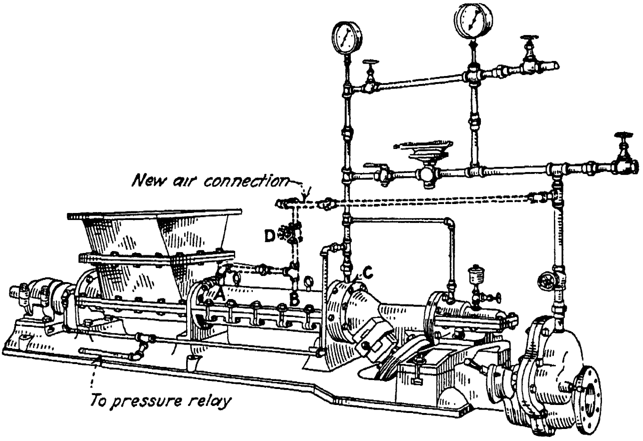

Fig. 8.—Additional air connection to screw barrel prevents pump from clogging on wet coal.

through both cover and barrel, the former being tapped for nipples, and connections made through a gate valve to the main air-supply line. Point A was made 1 in. from the hopper flange, and B 8 in. from the air-ring flange for the reason that the air on the ring would help to clear the screw at B, while it was necessary to keep the fuel agitated at this end. Possibly an additional connection midway between these two would have been helpful, but it has not been found necessary.

In operating, the procedure followed is to open the air valve to the ring supply C, start the pump, then open the valve D to connections A and B for about a minute. Before shutting the pump down, this valve is again opened but usually for a longer period. Should the pump start to hammer while running under load, thus indicating that a mass of wet coal has been introduced into the pump, the valve D may be opened until the pump is again running quietly.

29. This trouble could, of course, be eliminated by arranging always to have dry coal, which in itself will not plug the pump and which will not give off enough moisture to condense and cause a mass of wet coal to adhere to the sides of vent pipes.

30. Much can also be done to prevent plugging by arranging the vent pipes so that when these slugs do fall they cannot fall directly to the pump hopper.

31. For the first year of its operation, our plant was not equipped with protective relays, and ability to free the pump from plugging was of great help in maintaining service. Recently, relays have been installed, which cut out in proper sequence any apparatus that is affected by abnormal conditions. Perhaps the most important feature of this arrangement is that the plant is foolproof on starting up. The air-pressure relay originally had its supply from the main line, being set to pick up at a predetermined value. We found that we could start the pump, but not necessarily have air on the ring, so we connected the relay pressure line into the air-ring supply line on the low side of the reducing valve. Now it is impossible to start the mills or screw feeders unless the pump has air on the ring and is running.

Sanford, Maine. E. S. WOODWARD.

32. Tempering Coal in Furnace.

Bursting action in bituminous coal lumps can be attained if some fuel with a considerable quantity of volatile matter be added, especially that with low temperature of distillation and ignition, for instance, sawdust. Burning temperature will not be reduced, and stack loss will not increase. The volatiles are distilled off at comparatively high temperatures, close to the temperature at which the caking of the coal takes place; therefore the bursting action is greater than by using moisture.

The volatiles having low ignition temperatures are not only easily inflammable by themselves but also ignite the volatiles in the bituminous coal and even the heavy hydrocarbons which require high temperatures for ignition. Subsequently, there will be no caking into bunches or lumps, and the burning will be smokeless, as the fuel added improves the burning of the volatile matter in the coal, while the coal itself prevents the volatile matter from escaping too readily from the added fuel.

There are other materials that possess nearly the same virtues as sawdust, and should they be applied for the purpose of tempering coal it would be possible to pay high prices for them and still have profit.

Sometimes good results might be obtained by adding suitable brown coal screenings for which, however, it would be possible to pay more than it is worth, on a basis of its calorific value.

This method of tempering coal in the furnace is especially advantageous wherever the draft is somewhat limited.

Harbin, China. M. KOCHERJINSKY,
Bryner and Co.

33. Pointers on Burning Coke Breeze.

Burning coke breeze under steam boilers is more or less difficult if steady steaming is desired, because the clinker will granulate and bake to the grate. The best type of grate for burning this fuel is a flat one with deep bars, having a water trough or pan directly below to lower the temperature in the ashpit. The air needed for combustion is supplied under pressure between the grate and the water trough. Air supplied in this way is moisture laden, and this assists in cooling the bars and keeps them much cooler than otherwise. The cooler air, together with the moisture entrained, helps to prevent the clinker from granulating and sticking to the bars.

With ordinary boilers a long, flat pan capable of holding from 2 to 3 in. of water can be fixed in the ashpit. Then, as the hot ashes fall into the water, steam is given off, and this is carried into the fuel bed with the air. Ashes must not be allowed to accumulate in the trough or pan, which should be kept filled with water. This method enables the boiler to steam regularly and to be forced if necessary. The humid air has no bad effect on brickwork or other parts.

Birmingham, England. W. W. EMERSON.

34. Improved Method of Distributing Wood Refuse from Conveyor to Furnace.

A plow was constructed as shown in Fig. 9 so that it could be interposed between the sides of the conveyor trough. It was made adjustable so that it would intercept the refuse to a greater or lesser degree. To keep bark from sticking on the nose of the plow, it was given a wiping motion by connecting the end through a suitable movement to the running belt. We use one for each refuse chute. A considerable saving was realized.

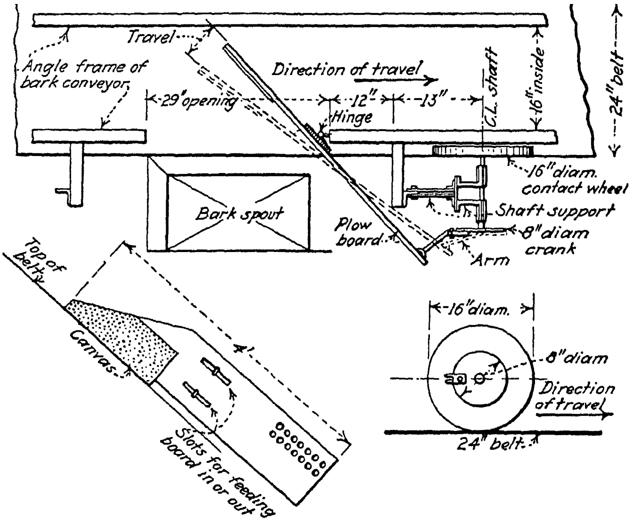

FIG. 9.—Wood-refuse plow given wiping motion by crank driven from contact wheel on belt.

Wisconsin Rapids, Wis. E. E. BELTER.

35. Loosening Clinkers with Steam Jets.

In operation of the hand-fired and semiautomatic types of stokers burning Midwestern coals at high ratings, it is necessary at intervals to remove the clinkers on the side walls with bars. This is a rather awkward process, owing to inclination of the grates.

We have installed a series of steam jets under the grates of two 72-in. by 16-ft. horizontal return-tubular boilers and have not had to use a bar the past season. The jets, drilled in pipe, $\frac{1}{16}$-in. holes spaced 8 in. on centers, are placed under the bearer bars so that they discharge their steam under the clinkers. When clinkers form that cannot be removed by operating the grate, we crack the valve leading to the jets until we can see steam coming through the fuel bed, and in 10 or 15 min. a pull on the levers loosens up the clinkers.

Beloit, Wis. S. W. STEARNS.

36. Soap Used in Water for Spraying Fly Ash.

Water is often used for spraying fly ash from pulverized-fuel furnaces. The efficiency of the process can be increased by adding soap to the water, which causes it to adhere to the dust more readily. The amount of soap required is largely a matter of trial and error; it is usual to begin with 1 lb. of soap per 50 gal. of water and to increase the amount gradually to the point at which dust removal is most efficient. The character of the water affects the amount of soap which must be added, some waters being hard and requiring considerably more soap than others.

Hertfordshire, England. W. E. WARNER.

37. Supplying Oil Fuel from a Central Point to a Number of Services.

Where oil is used for fuel in various divisions of a large plant, difficulty is frequently had in keeping it hot enough to flow freely in the pipe line. We concluded that the simplest way to overcome our troubles was to arrange the pipe in the form of a loop.

The original supply line connected the three boilers in the power plant and the forge, blacksmith shop, and heat-treating plant. We added a return line. With this arrangement considerably more oil is circulated than can be utilized at the various points, and as a result temperature and viscosity are maintained at the proper point.

Buffalo, N. Y. B. C. ALLAN.

38. Circulation in Oil-heating Coil Remedied.

It is customary to use heating coils in fuel-oil tanks, particularly when heavy-grade oil (14 to 16° Bé.) is used. We had a tank 8 ft. deep buried in the ground between two adjacent buildings. The vacuum pump was 4 ft. above the bottom of the tank in the boiler room, a considerable distance from the tank. We used a 1½-in. coil with 1½-in. supply and return pipes, which were at the same level.

When steam was turned into the coil, the vacuum pump could not create circulation in the coil. A steam trap was installed at the bottom of the coil in the tank. Still there was no circulation. The following changes were then made:

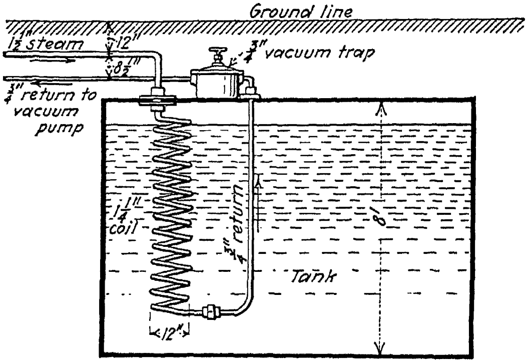

Fig. 10.—Arrangement of coil and trap connections.

The steam-supply pipe was kept at 1½-in. diameter, but the coil was made of 1¼-in. pipe. At the end of the coil the vertical line was made of ¾-in. pipe and was carried to a vacuum trap outside the tank. From the trap a ¾-in. return pipe was carried to the main return connected to the vacuum pump. The steam line was placed 8½ in. above the return, as in Fig. 10.

When steam was again turned on, a good circulation was obtained with 2 lb. pressure and 3 in. vacuum on the return line.

Chicago, Ill. IGNACIO IZSAK.

39. Damper Control Proportions Air for Oil Furnace.

An oil pump and fan driven by a constant-speed motor was used at one plant, burners being air atomizing. Oil pressure to the burners was controlled by a pressure-regulating valve actuated by boiler steam pressure. Air for atomization or primary air was supplied by the fan, while secondary air was drawn in through checkerwork under the burners and back to the bridge wall, as is the usual practice.

The trouble with this system was that when steam pressure went up, automatically cutting down on oil supply, air flow remained constant. This resulted in a high percentage of excess air every time load on the boiler dropped. Cooling of the furnace walls followed, as well as a big drop in CO_2.

A definite quantity of oil was burned in bringing the furnace walls back to their original temperature, at which time the regulator again opened.

As do most plants changing from coal to oil equipment, our plant possessed an automatic damper regulator which had been discarded. This regulator was used to great advantage in correcting the condition mentioned. The diaphragm was replaced with a copper one. The regulator was then connected to be under control of oil pressure instead of steam. It was then connected to the uptake damper in the reverse of its former method, that is, when the oil pressure dropped the damper closed. A stop was provided so it could not close beyond a point that would cause a positive furnace pressure. It was connected to the oil line instead of steam so in case of any accidental opening of the oil-regulator valve, there would be no danger of a flareback.

This arrangement proved very satisfactory.

Milford, N. J. HARRY M. SPRING.

40. Regulating Air to an Oil-burning Furnace by Appearance of the Smoke.

In oil-burning plants not completely equipped with instruments, regulation of air to fires is usually governed by the appearance of the smoke from the stack. Manufacturers of oil-burning equipment usually recommend that the air be so regulated that a light brown haze will issue.

In a great many plants, it is necessary for the fireman to go some distance to get within sight of the top of the stack, and therefore he does not watch the smoke so closely as he should.

In plants equipped with water-tube boilers of the type that has the small dusting doors in each side of each pass, a 50-watt electric bulb of the clear-glass type may be hung in front of a door near the top of the last pass. If the door on the opposite side is opened, the light may be seen across the pass of the boiler. If the air supply is as it should be, the filament of the bulb should be seen clearly but not brightly across the pass of the boiler. The proper appearance of the light across the pass must be determined by comparison with the smoke issuing from the stack. Once this appearance is determined for a particular plant and the firemen know just how bright the light should appear, it is easy for them to observe the smoke condition frequently.

This idea may be used where the construction of the boilers does not permit the use of the method described above, by making two small holes opposite each other, at some convenient point in the breeching and fitting these holes with plugs or covers. The observation may then be taken across the breeching.

Brooklyn, N. Y. P. F. CALLAGHAN, JR.

41-44. Four Hints on Lighting Oil Burners.

41. Experience has taught us not to depend on the incandescence of the brickwork to ignite oil burners of any type once they go out, even only for a few minutes.

42. Hand torches are not safe and should be discarded, as they require the attendant to get too close to the burners when starting up.

43. The device that we have developed for lighting an oil-burning furnace consists of a No. 10 gage iron shield at right angles to the boiler front, on which there is a device for lighting the fires. A city gas pipe passes through the shield with a valve on the outside. A Ford spark coil operates from a bell-ringing transformer on a 110-volt alternating-current line. The coil has one terminal grounded to the gas pipe, the other terminating at the gas pilot to effect a spark gap. A push button closes the circuit. Additional features are two controls, one for oil and one for air.

The employee lighting the fire is instructed to have the damper fully open, and the blast gate open for a few minutes, then closed tight.

With the gas on, the push button is pressed, producing a spark at the pilot-light burner. This lights the pilot. The oil is then turned on, and the intensity of the fire regulated by opening the blast gate. When the initial small fire has been burning for some minutes, air and oil controls are opened until the proper fire is obtained.

The tip of the pilot light gave us the most trouble. We solved this by placing a piece of $\frac{1}{8}$-in. pipe in a block of firebrick cement, pressing in a piece of wire as shown in Fig. 11, and then baking it in a furnace to harden.

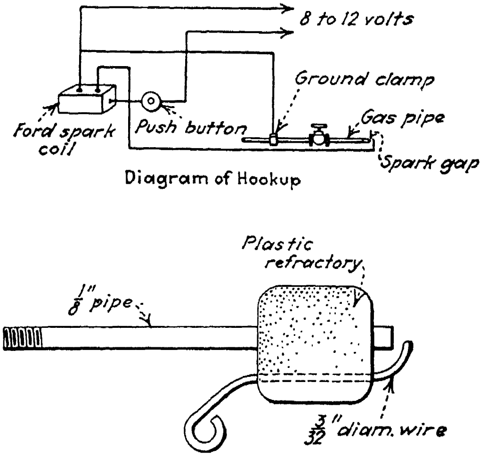

Fig. 11.—Diagram of ignition hookup and detail of pilot.

44. Damper and blast gate should be left open when starting the burners, and the pilot light kept lighted, in case the burners should go out after starting.

Bridgeport, Conn. G. C. Mauter.

45. Improves Fuel-oil Heater Operation.

A simple change in the oil connections of a multicoil fuel-oil heater greatly improved its operation. To heat the oil, which as a rule was of a low gravity, it was necessary to carry between 100 and 125 lb. steam pressure at the heater. I thought this was unusually high and decided to try a few changes in the heating arrangement.

Oil flow was counter to the steam and all heaters were connected in parallel as to steam and oil. I made no change in steam connections or direction of flow, but forced oil to pass through each heater consecutively, entering on one end of the series of heaters and discharging at the other. Perhaps this is contrary to best engineering practice, but results quite justified the change.

The alteration in connections (Fig. 12) consisted of substituting four T's for elbows and adding nipples and unions, as indicated by the dotted lines. This permitted the heater to be run the old way in case of a break in any of the coils, which could not be done with the heaters connected in series, without shutting down the whole system.

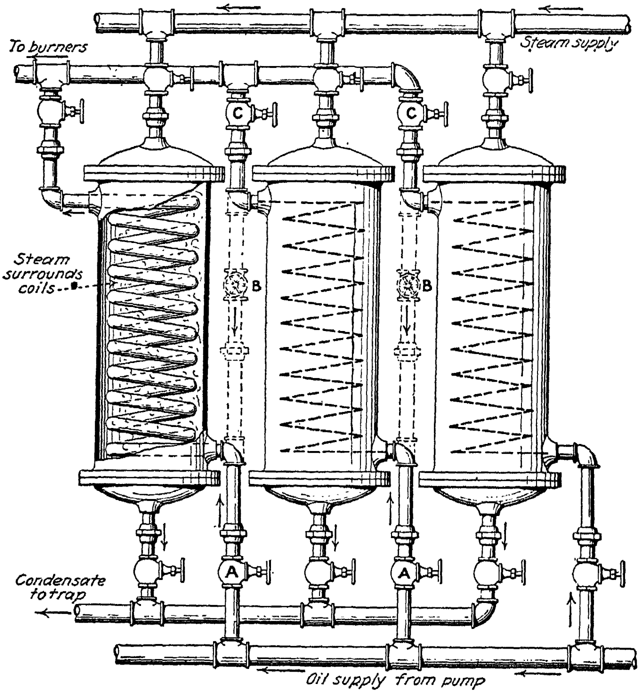

Fig. 12.—Series-parallel connection of fuel-oil heater.

Valves *B* were opened to operate the coils in series and valves *A* and *C* were left closed. For repairs to any individual coil, valves *B* were closed and valves *A* and *C* opened, then the single bad coil was cut out by closing off its valves.

This change permitted us to drop the steam pressure from 100 lb. to between 25 and 30 lb. and a more uniform temperature was maintained on the oil.

Union City, N. J. RUDOLPH BOETTINGER.

46. Heavy vs. Light Fires.

Results of operation with both heavy and light fires have shown that with a light fire it is possible to obtain the following betterments:

Thirty per cent increase in boiler rating with 1 in. less forced-draft pressure.

Fire cleaning time reduced to one-half.

Two to three per cent greater efficiency.

High ratings are obtained only by rapid and intense combustion. Such combustion is necessarily complete and most efficient. All these results are obtainable by operating with thin fires and without the risk of a great loss in efficiency due to the infiltration of air.

New York, N. Y. William Welch, Jr.,
Assistant Mechanical Engineer,
Interborough Rapid Transit Co.

47. How Oil-car Valve Was Opened.

We received a car of fuel oil in which the operating rod had become disengaged from the valve at the bottom. With normal conditions, when cap *A* (Fig. 13) is removed, the unloading hose is attached to part *B*. Then the valve is opened by turning handle

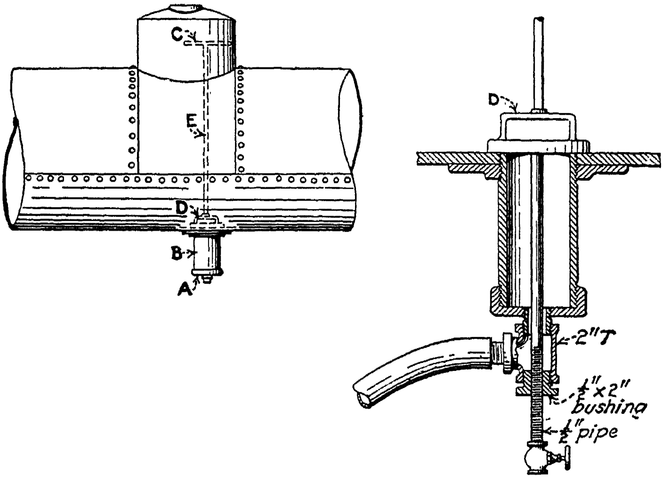

Fig. 13.—Pipe with running thread used to push valve off its seat.

C, which, in turn, lifts valve *D* off its seat, allowing the liquid to run out.

Rather than pump the contents of the car out of the top, we made up an attachment to push the valve off its seat. Cap *A* had a 2-in. plug in the bottom. This was removed and a 2-in. close nipple and T were screwed in. After fastening the unloading hose to the side outlet of the T, we tapped a bushing to take a ½-in. pipe having a running thread. The pipe and bushing were screwed in place, and a ½-in. valve was put on the lower end of the pipe. When everything was ready the pipe was screwed upward, and the valve pushed off its seat.

Charlotte, N. C. GEORGE G. AVANT.

48. Cleaning Oil Tank from Outside.

Recently, we found it necessary to clean the sludge out of an oil-storage tank, and as this is a rather disagreeable job to do in the usual way, we tried floating the sludge with water and using the improvised skimmer or ejector shown in the illustration. As no standard ejector was available, we made one from a pipe T by fitting a steam nozzle in the run of the T and a large funnel to the side outlet, as shown in Fig. 14.

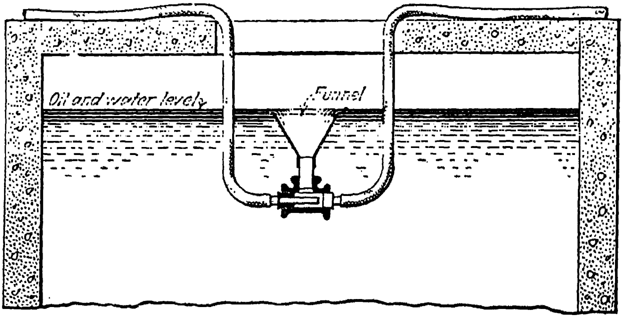

FIG. 14.—Steam ejector used as skimmer for sludge.

To stir up the sludge in the bottom of the tank and cause it to float, we used a fire hose with the nozzle directed through the manhole in the top of the tank. When the level had been raised close to the top of the tank, we turned the steam on the ejector and then raised or lowered the funnel as necessary by means of the steam and discharge hose.

Chicago, Ill. A. C. BROWN.

49. Balanced vs. High Induced Draft.

I am of the opinion that, with the same conditions and thickness of fuel bed, better results must be obtained with balanced draft than with high induced draft. This opinion is based on the fact that with balanced draft a larger part of the heating surface is more effectively used than with high induced draft, and consequently it is as if heating surfaces, economizers, air heaters, etc., were added to the boiler.

Paris, France. MAURICE RATEL,
Foyers Automatiques Ratel.

50-51. Two Ways to See Smoke at Chimney Tops.

50. A point is selected from which a clear view of the stacks can be had and which can also be seen from the boiler room. At this point, place a convex mirror, then by proper adjustment the image of the stacks can be seen from the boiler room. Size of image and field range are controllable by varying the diameter and focal length of the mirror used. The distance from the observer to the mirror should not be more than 50 feet.

51. If it is not possible to place the mirror in the way described, an arrangement that may be termed an "open periscope" can be used. Place the convex mirror at a point where a clear view of the stacks may be had, in such a way that a reflection of this mirror will be visible in a plane mirror placed within 10 ft. of the observer. The stack reflection in the convex mirror will then be visible in the plane mirror when properly aligned.

Brooklyn, N. Y. BARRY M. TURNER.

52. Preheating Fuel Oil in the Boiler Furnace.

Our oil heaters, when first installed, were connected in parallel and utilized exhaust steam from the oil pump. The oil was received at the rate of approximately 9,000 gal. a day at from 140 to 190°F., and, as it was recirculated, the temperature at the suction of the pump was about 114°. After passing through the heater, the temperature was about 135°, but on account of the distance from the pump house to the burners the temperature dropped to about 122°—much too low for proper atomization.

We later connected the heaters in series, and the temperature increased about 20°. We then lagged the heaters and raised the temperature about 8° more, but the temperature of 150° at the burners was still too low.

The chief engineer then conceived the idea of heating the oil by circulating it through the boiler furnace. After it had gone through the oil meter, it was run into the furnace through a 1-in. pipe and back into the line that fed the burners, as in Fig. 15. Firebricks were placed on top of the pipe in such a way that they could be removed by a bar if the oil was not hot enough. Valves were placed on the line in such a manner that if anything happened to the piping within the furnace, the burners could be operated at the lower temperature as previously.

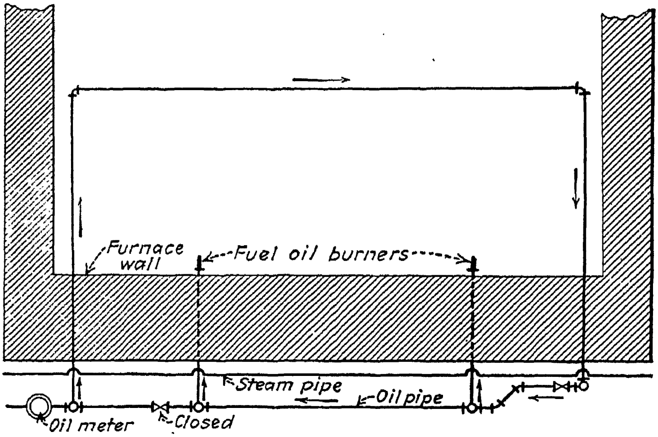

FIG. 15.—Pipe in furnace serves as secondary heater.

The improvised heater proved satisfactory and saved us the cost of a new steam heater. After removing a few bricks, we found that the oil temperature, after passing through the furnace, averaged about 210°, varying from 200 to 212°, which was the temperature that we desired. No carbonization has been noticed.

North Woburn, Mass. W. H. SCOTT.

53. Electric Eye Controls Gas-fired Boilers.

To the plant engineer of the Godchaux Sugar Refinery, Reserve, La., goes credit for the ingenious pressure-control apparatus of Fig. 16. A small hole is cut in the steam-gage dial at the pressure for which regulation is desired. A similar hole is cut on the other side of the dial but not quite opposite the first one. The regular gage hand is replaced by a long hand with metal flags large enough to cover the holes.

As steam pressure increases, the right-hand flag moves down in front of the hole, thus interrupting the beam of light to the photoelectric cell. This causes the relay to energize the coil of the relay valve on the gas line and open the valve. Gas under pressure enters the cylinder from the main and moves the piston, which in turn partly closes the butterfly valve in the line to the burners.

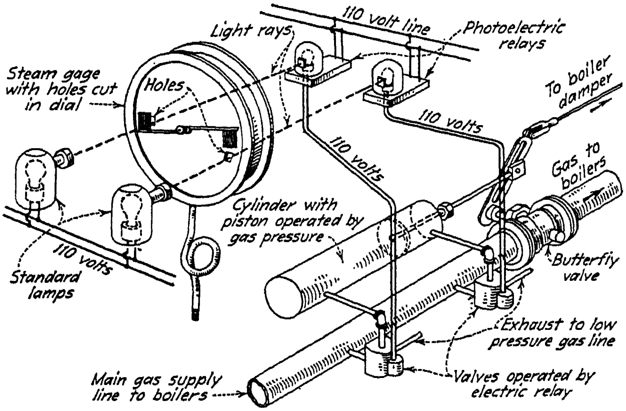
110 volt line
Light rays
Photoelectric relays
Steam gage with holes cut in dial
Holes
To boiler damper
110 volts
110 volts
Gas to boilers
Cylinder with piston operated by gas pressure
110 volts
Standard lamps
Butterfly valve
Exhaust to low pressure gas line
Valves operated by electric relay
Main gas supply line to boilers

FIG. 16.—Photoelectric control for gas-fired boilers.

As the fuel supply decreases, steam pressure drops. When the pressure reaches a predetermined low limit, the flag on the left covers its corresponding hole in the steam gage, and its photoelectric relay opens the butterfly valve in the gas line. More fuel enters the burners, and steam pressure again increases. This device is said to regulate pressure within a limit of 3 lb. The butterfly is so adjusted that gas cannot be turned completely off, and a by-pass is provided around the valve for use in case it is desired to cut the regulator out of service.

54. Does Wetting Coal Improve Combustion?

While working on the design of small underfeed stokers we had one installation where very fine coal was used. In fact, the coal consisted mainly of yard sweepings and dust. We found that wetting this coal greatly improved combustion.

As to the fact that the coal does not clinker so badly, it is my opinion that the water is converted to superheated steam and, in passing through the fire, cuts down the tendency to clinker in the same way as steam used to stop clinkering and slagging at the sides of the grate against the furnace wall.

Pulaski, Va. R. H. BARTH.

55. Putting water on dirty coal agglomerates the dust particles and in doing so reduces the resistance of the fuel bed. This allows more air to pass, increasing the rate of combustion. An increase in the combustion rate gives a higher furnace temperature. The better mixture of air and carbon facilitated by the decreased resistance of the fuel bed and the agglomeration of the dust particles gives combustion with less smoke. The moisture added also retards the distillation of volatile matter, which reduces smoke, and this is likely responsible for the coal's not coking into such hard lumps.

Haslam and Russell, in "Fuels and Their Combustion," explain that a moisture of 5 per cent or less is an advantage in speeding up the CO combustion rate. Above that, however, it is a detriment. That would also increase the furnace temperature and decrease smoke.

The presence of larger quantities of moisture acts to lessen the concentration of the reacting gases, which retards combustion and reduces the furnace temperature.

Keyport, N. J. GEORGE B. LONGSTREET.

56. The benefits of wetting coal to improve combustion apply only to furnaces using natural draft. Coal of the pea and slack variety lies compactly on the grates, making it difficult for enough air to pass through for proper combustion. When wet coal is used, steam is generated in the fuel bed. This steam, in passing out, leaves the bed in a porous condition, allowing enough air to pass through for better combustion. Where forced draft is used, wetting down is not necessary.

Louisville, Ky. JOSEPH L. BROWN.

57-59. Three Experiences with Ignition Arches.

The sprung ignition arches under our new water-tube boilers have given considerable trouble.

57. We tried a flat-suspended arch installed by experts. The brick spalled badly at first, but we were able to stop this trouble. The suspending steel, beams, etc., warped and had to be replaced.

This arch showed no advantage over the sprung arch and cost more to keep in repair.

58. Fire clay shrinks in burning, the amount of shrinking depending upon the proportion of unburned to burned clay used. If the bricks in the arch rest upon the fire clay, the arch will, of course, settle by the combined shrinkage of the joints. Hence the bricks should be fitted together, and the clay used only to seal the joints. If the plasticity of the brick at high temperatures is considered, it is easy to understand why sprung arches fail.

59. There was not much room for arches, so that little change could be made in form. We raised the arch as much as possible, which helped some. The back end of the arch after a few runs would droop down, and bricks fall out—sometimes singly, sometimes in groups. Most of the arch was good, but we could not get along without the back end of it. We then blocked up the back end of the arch form 4 in., as shown in Fig. 17, and built an independent arch 18 in. long over the back end of the ignition arch but 4 in. lower. It had the same spring and was built like the other arch, with the bricks carefully fitted and tied together. The arches were separated about 1 in. Space between arches was covered over loosely with tile or brick. The short arches were built to take part of the wear off the ignition arches. This they did surprisingly well, and our arches gave little subsequent trouble.

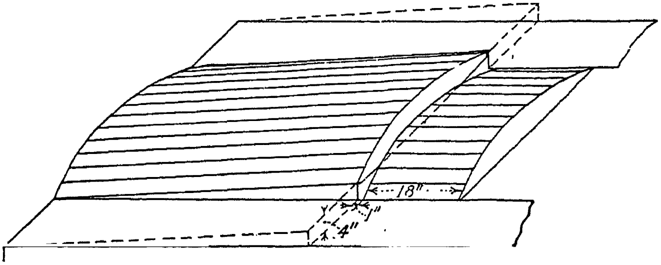

Fig. 17.—Form on which sprung arch was built, showing position of short independent arch.

Elgin, Ill. W. L. Parker.

60-66. Seven Hints on Care of Rotary Mechanical Oil Burners.

Of considerable importance in proper operation of mechanical oil burners of the rotary type is care of the burners while out of service. This applies especially to small plants where the fires are put out each night.

60. Many engineers soak the burner in a bucket of kerosene until it is wanted. Kerosene will easily dilute the heavy fuel oil and any gummy residue left in the burner, but the burner should not be left in the kerosene indefinitely.

61. In a plant that shuts down every night, the burner should be removed from its mounting as soon as the air is shut off, to prevent excessive heating from the radiation of the furnace.

62. If the oil is shut off several minutes before the air, it will drain the feed tube and bowl, making cleaning much easier.

63. The burner should be dismantled and thoroughly cleaned with a brush and kerosene. If possible, it should then be blown out with air. All bearings should be lubricated with light machine oil and placed in a rack to drain.

64. In many plants, at least one spare burner is kept on hand. It should be kept clean and ready for operation at all times.

65. When removing or handling the burner, care should be taken not to strike it against anything to dent or scratch the brass bowl, as any distortion in its edge will result in improper atomization.

66. In operation, any accumulation of carbon under the burner should be broken up with a bar and removed, because it will be likely to cause overheating. The reason for such accumulation should be determined if it forms in excessive amounts. Probably it will be found to be due to dirty or damaged burner, poor quality of oil, wrong proportion or ratio of air-oil supply, wrong oil temperature, or wrong size of burner tip for load carried. The temperature regulator may be set for good operation with one particular oil, but the next carload may vary enough to require a different setting.

Milford, N. J. HARRY M. SPRING.

67. Boiler Efficiency Dropped Off.

After an 84-in. horizontal return-tubular boiler with a hopper-feed hand stoker had been installed and a test run made, a high average CO_2 and an evaporation of approximately 10.5 lb. of water per pound of coal was obtained. This gradually dropped off inside 30 days, so that the estimated fuel consumption was exceeded.

Rubbish, consisting of papers, boxes, and other combustible material, was sent to the boiler room to be burned, and with the old boilers going out, it had to be burned in the new boiler, which was the direct cause of the lowered efficiency. When the test run had been going on, one old boiler was still on the line, and all the rubbish was burned under it, so that nothing but coal went into the furnace of the new boiler. Putting in the rubbish took up so much time that much excess air entered through the fire doors. Pressure allowed on the old boilers was even higher than that allowed on the new boiler, so we decided to keep one of them. With this boiler again in service to burn the rubbish, the efficiency of the new boiler went up to test figures and stayed there. Output of the rubbish-burning boiler was 1,000 lb. of steam per hour for 15 hr. a day. Had no other boiler been available it would have paid to install a small one especially for this purpose.

Springfield, Mass. A. F. SHEEHAN.

68. Auxiliary Oil Burner Saves Fuel.

Central Building, Seattle, Wash., is equipped with a marine-type double-furnaced boiler having 1,200 sq. ft. of heating surface and operating at 4 to 6 lb. pressure, supplying steam for building heating only. Each furnace has one burner, using 15°Bé. fuel oil at 20 lb. pressure and 130°F.

The boiler is on from 6 A.M. to 5 P.M. In past years, it had been necessary to cut in a small boiler at 5 P.M. to carry evening load. This resulted in an average evaporation of about 9 lb. for the two boilers and trouble with the large boiler due to cooling down overnight.

This year we installed a small auxiliary rotary burner in the side of one of the furnaces of the main boiler. An extension tip was constructed through the side wall. The burner was placed about one-third of the way back from the front of the furnace, just outside the combustion cone of the main burner.

In cold weather, the auxiliary burner is cut in at 5 P.M. and off at 7 P.M., and in mild weather it may go on at 10 A.M. and run until 7 P.M. without the main burners. This conserves and holds heat in the main boiler setting, saves oil, and average evaporation is now between 12 and 15 lb.

Seattle, Wash. CHARLES H. CHURCHILL.

69. Changing Position of Burners Corrects Refractory Troubles.

Pulverized-coal burners for a boiler plant were originally placed in the front wall of the furnace. After the boilers had been in service about a year, the bridge walls showed severe spalling and erosion, because the flame impinged directly on them. New bridge walls were laid and lasted six months. Gradually increasing load on the boilers called for greater heat release in the furnaces. The boiler and fuel-burning equipment could easily handle the increased load if the refractories could be made to stand up. The difficulty was corrected by constructing miniature Dutch ovens of steel plate bent into the shape of cylinders. These were lined with firebrick. This allowed the burners to be mounted about 3 ft. back from their original positions, as in Fig. 18.

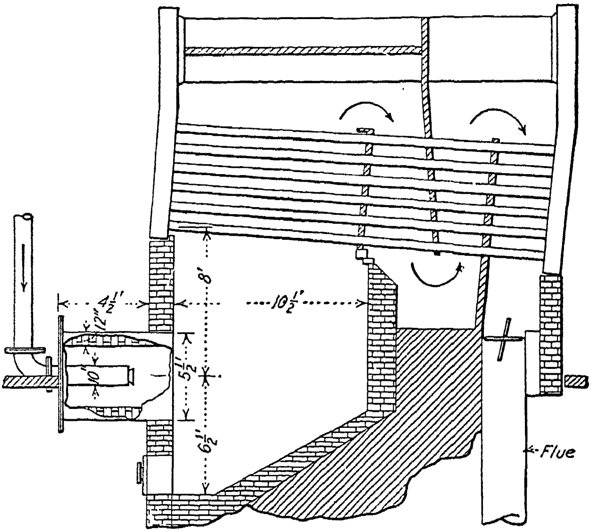

Fig. 18.—Burners moved back 3 ft. by building Dutch ovens.

As a result of this change, an appreciable increase in combustion efficiency was noted; besides, refractory maintenance was reduced to below that considered normal for boilers operating at their ratings.

Milford, N. J. Harry M. Spring.

70. Simple Combustion Control for Stoker-fired Furnaces.

The illustration shows a simple combustion control, which we worked out a year or two ago and which has proved entirely satisfactory for controlling overfire draft on underfeed stoker-fired furnaces. In order to have a constant check on operation of the control, a 1-in. differential draft gage is mounted on the boiler front in a convenient position and connected to the furnace in the usual manner.

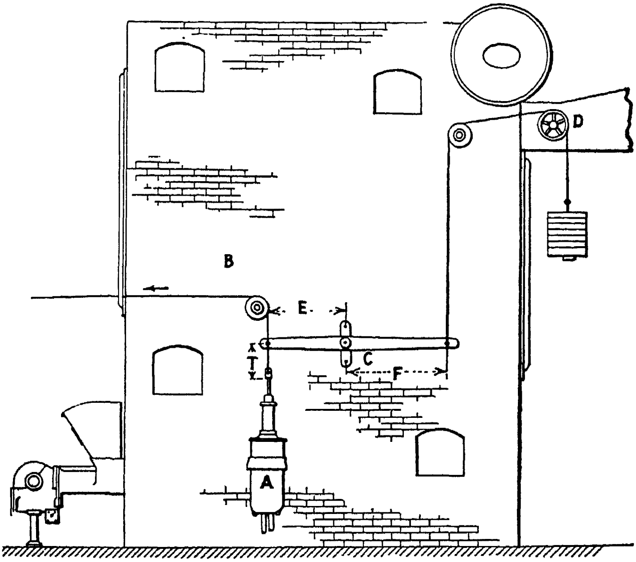

FIG. 19.—Compensating regulator controls speed of fan engine and position of stack damper.

A is a steam-operated compensating damper regulator (Fig. 19). Cable *B* is connected through idler sheaves to the fan-engine control valve, which in this case is a chronometer lever-operated valve. Compensating lever *C* connects through cable and necessary idler sheaves with 18-in. chain wheel *D* on the stack damper shaft.

A piece of chain over wheel *D* allows adjustment to be made by raising the chain off the sprocket and shifting it a link or two at a time until desired overfire draft is obtained. This draft, once adjusted, will remain within 0.02 in. at all positions of the damper, because with a sprocket the travel is uniform instead of variable, as with the conventional lever.

The ratio of distance E to F on lever C must equal the ratio of distance T to one-fourth the circumference of the sheave D, because sheave D must make a quarter turn while the piston on regulator A travels the distance T. Likewise, the lever on the fan-engine control valve must be of the correct length, so that the point at which the cable B connects will travel a distance equal to T on the regulator.

Cable B can be connected to the individual boiler blast gate or to the individual control valves on small turbine-driven blowers, in which case sheave D is also located on the individual boiler damper instead of the main stack damper.

Westwood, N. J. R. J. NAGLE.

71. Gas Furnace Alarm.

To keep furnaces, muffles, etc., hot when not in use, as during nights, Sundays, and holidays, gas burners are turned down as low as possible and allowed to run straight through.

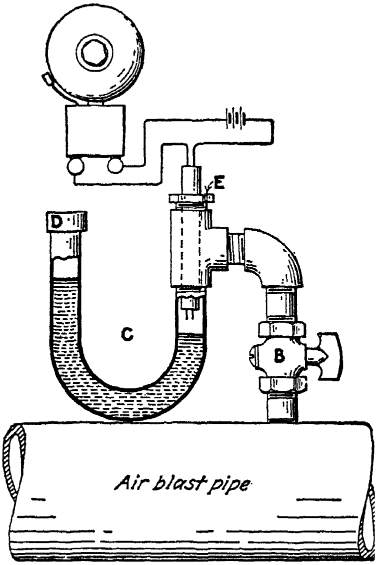

FIG. 20.—U-tube mercury alarm to indicate stoppage of air flow.

If there is sufficient draft to the furnace, the fan may not be required at such times, but in many cases fan blast is desirable. Under certain conditions, the fan may stop. At such times, if no one is at hand to turn off the gas, some of it may make its way back into the blower pipes. This mixture of gas and air finally becomes rich enough to explode.

To prevent such a contingency, the simple device in Fig. 20 for sounding an alarm the moment that the flow of air to the furnace is interrupted has been used. Through cock B, with nipples, elbow-and-T connection is made between the blast pipe and U-shaped bent tube C. Attachment to the blast pipe can be made by soldering and reinforcing before boring the hole, or the device can be hung on the wall, and connection made with a rubber tube. Into the lower end of the T is screwed the bent pipe *C* partly filled with mercury. The open end of the tube has cap *D* loosely sitting over it, while bushing *E* is screwed into the upper end of the T. Through this bushing two wires lead downward into the tubes. The other ends of the wires lead to an electric bell and battery, which may be placed at any convenient point. If desired, two or more bells may be connected in the circuit.

While there is pressure in the blast pipe, the mercury in the bent pipe *C* will be depressed away from the wires. If, however, the pressure fails, the mercury will equalize in the two legs of the tube, short-circuiting the wires and causing the alarm to sound.

Elgin, Ill. W. L. Parker.

72. Protects Oil-tank Gage against Surges.

When oil in the storage tank in Fig. 21 was withdrawn to below the center of the tank, the boiler-room indicating wall gage would register empty. Copper tubing *T* was found bent into the position shown. When oil was pumped to the storage tank, it caused surges that bent the tubing.

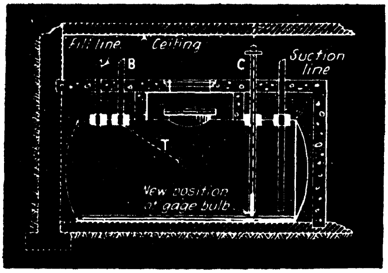

Fig. 21.—Rearrangement of tank piping prevents surge difficulties.

To overcome this difficulty, the hydrostatic bulb for the gage was disconnected, the concrete around the pipe being broken sufficiently to permit doing the work. Vent line *C* was disconnected at a convenient ell above the tank and reconnected where the oil gage was formerly connected. A man entered the tank and screwed a piece of pipe into the back side of the bushing of pipe *C* to act as a conduit for the bulb and tubing of the gage. The hydrostatic bulb was slipped through the coupling of the pipe and lowered to the tank bottom. The bushing was then tightened into the pipe coupling and the gage line completed. Fill and suction lines were not changed.

Brooklyn, N. Y. William Anderson.

73. Why Boilers Shake.

I have personally encountered serious vibrations of boilers when fired with gas, especially with the multijet burner where a group of small jets fire through holes in a casting. This has occurred on all types of boilers from 500-sq. ft. horizontal return-tubular to 10,000-sq. ft. water-tube boilers.

This usually occurs when the draft is sufficiently high to induce a good mixture of air with the gas.

Admission of secondary air or lengthening of the flame away from the burner stops the vibration.

Tulsa, Okla. C. W. STEVENS.

74. Pilot-valve Regulator Replaces Mercury Column.

Figure 22 shows an interesting application of a pilot-controlled pressure-regulating valve to an automatic combustion-control system. Mercury columns did not operate satisfactorily. It was decided to replace these columns with pilot-valve control and retain the remainder of the combustion-control system.

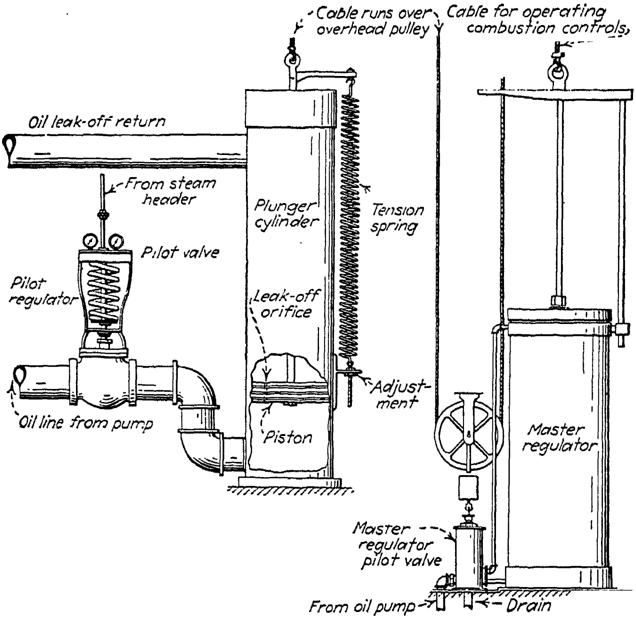

FIG. 22.—Pilot-controlled pressure-regulating valve applied to automatic combustion-control system.

A brass cylinder and plunger assembly was available. Two ports were located, one near the top of the cylinder and one at the bottom. The only change necessary was to drill a ¼-in. hole through the piston as a leak-off orifice. The lower port on the cylinder received direct oil pressure from the pump at 100 lb. per square inch. The top port served as a return to the oil-pump suction reservoir. The same oil pump served the plunger cylinder that was previously installed for the regulating system. The eye of the plunger was connected to the master-regulator pilot valve to which the mercury float had been connected previously.

Increasing pressure in the pilot-valve tube causes the regulating valve to close gradually in proportion to any steam-pressure increase. Spring tension on the plunger rod then causes it to assume a new and lower position according to the oil leak-off through the orifice at the new oil pressure. When the plunger lowers, it moves the master-regulator pilot valve, causing this regulator to take a new position. Several major functions may be controlled through this by cable, linkage, or electrical connections.

Conversely, on a drop in steam pressure, the pilot regulator opens the oil-line regulator and increases the flow of oil to the plunger cylinder. This flow is more than the orifice can accommodate with the existing spring tension, and the oil pressure increases under the plunger and raises it to a new position, determined by the oil flow allowed by the regulating valve.

Cleveland, Ohio. M. E. WAGNER.

75. Substituting High-pressure Gas for Steam Saves Buying New Blower.

Our gas plant supplies a town of 20,000 population with carbureted water gas. Each of the two gas generators is equipped with a waste-heat boiler, and when both machines were being operated in parallel, sufficient steam was produced to drive the blower and supply the generators. But in the warmer months, when only one generator was in operation, the steam produced was insufficient.

As the extra amount of steam required was not great, we got it from an adjacent electric plant, and it was not a serious item so long as the boilers had to be kept on the line anyway; but when the boilers came to be used for stand-by only, the thing that prevented them from being banked for hours at a time was the necessity of supplying that small amount of steam to the gas plant. It was evident, therefore, that a motor-driven blower in the gas plant would be a good investment.

Before purchasing the new blower, however, we cast about to see what could be done with the existing equipment. Now we normally store about 100,000 cu. ft. of gas at a pressure of 100 lb. gage. We use a motor-driven compressor to handle it, and since this compressor is of sufficient capacity to take care of our maximum output with two machines in operation, it is only partly loaded when only one gas machine is being used. Since the storage pressure is almost as high as the normal steam pressure on the waste-heat boilers, we figured that one of the steam-driven blowers could be run on the high-pressure gas, exhausting back into the compressor suction.

It was only a small job to arrange one of the blower engines for either steam or gas drive. We found that operation on gas pressure was just as satisfactory as on steam and that the additional load imposed on the gas compressor amounted to only a few kilowatts.

Lake Charles, La. M. F. KNOY.

76-80. Five Reasons Why Operating Costs Were High.

A change was made from solid to liquid fuel in a boiler plant having two horizontal return-tubular (h.r.t.) boilers with a total heating surface of 3,500 sq. ft. In connecting the oil burners to the boiler furnaces, the engineer could find no convenient place for connecting the steam supply to the burner under the larger boiler. He hit on the idea of making a connection to the 1¼-in. steam line that joined the boiler to the top of the water column.

Things went well for a few days. Then one night during the peak load the top rows of tubes began to leak, and finally conditions got so bad that it was necessary to take the boiler out of service.

76. It was found that all of the top row of tubes would have to be replaced, as they were badly burned because of low water. With steam flowing at high velocity to the burner during the peak load, a false water level was indicated due to lifting, or syphoning, of water in the water column; consequently, while the glass indicated a safe water level, the actual level was too low.

77. The fuse plug in the rear-tube sheet was too short to project well beyond the inner surface of the tube sheet, and a heavy coating of hard scale prevented the fusible material from melting and giving warning of the low water condition.

78. In the same plant, exhaust steam from a duplex fuel-oil pump was connected to an inclosed-type feed-water heater after first passing through the heating coils of the fuel-oil heater. After a few months, a leak developed in the steam-heating coil of the unit, and because the oil pressure inside the tubes of the coil was considerably higher than that of the exhaust steam fuel oil leaked into the steam space, a part of which ultimately reached the feed-water heater and adhered to the tubes, acting as a heat insulator between the water and the exhaust steam. After the leak was discovered and repaired, pump exhaust was turned to atmosphere direct.

79. When the change was made to fuel oil, an oil-storage tank of about 12,000 gal. capacity was installed. The tank was placed in a shallow pit in the rear of the boiler room and connected to the fuel-oil pump suction. But it was not anchored in place. The following summer an unusually heavy rain flooded the low ground and tank pit. The tank was only about one-third full of oil, and it floated away from its location, breaking the suction pipe and shutting down the plant, in addition to causing the loss of considerable oil.

80. In another plant, a cross-compound condensing Corliss engine operated for several years with 17 to 18 in. of vacuum. As time went on, it became difficult to maintain even this low vacuum, and no one seemed to know what to do about it. A change in chief engineers solved the mystery. When the unit was installed, the exhaust pipe had been extended through a trench which was later covered over with concrete to a point beyond the engine and dead-ended with a blank flange on the side outlet of a T. The blank flange was made from a piece of thin sheet metal and bolted in place with the usual gasket between the face of the fitting and homemade flange. The other end of the T was fitted with a companion flange into which a plug had been screwed. In time, the light, homemade flange buckled inward, partly destroying the joint between flange and fitting and allowing air to leak in. As the pipe was well covered, no evidence of the leak could be noted until the floor was dug up.

Atlanta, Ga. C. T. BAKER.

81. Photoelectric Cell Protects Boilers.

On oil, gas, or pulverized-coal fired boilers, there is always the danger of an explosion should the fire go out accidentally. This installation consists of a photoelectric cell mounted in a pipe reaching through the wall of the furnace so that the cell will be acted upon by the light from the fire. The cell is far enough away from the fire so that it will not be injured by heat.

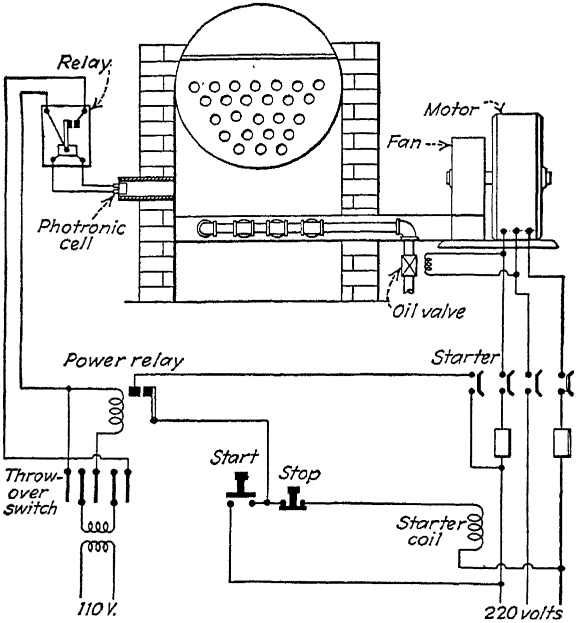

FIG. 23.—Photoelectric cell shuts down draft fan and closes oil valve if fire goes out.

A sensitive relay connects to the photoelectric cell (Fig. 23) and controls the circuit to a power relay. As long as the fire burns and the light strikes the cell, the sensitive relay is held closed to complete the circuit through the power-relay coil. The latter's contacts complete the circuit for holding the draft-fan-motor starter in the running position and for holding the fuel valve open.

If the fire happens to go out, the photoelectric cell functions to open the sensitive relay to shut down the draft fan and close the oil valve.

New York, N. Y. JOHN ALLEN MURPHY.

82. Photoelectric Cell Insures Ignition Flame.

We use a photoelectric cell on the furnace of a 16,500-sq. ft. boiler to insure an ignition flame, should the fire go out. It was prompted by a number of bad puffs caused by momentary coal-feed stops on some of the mills. Surface moisture in the slack bituminous coal that we use varies widely with weather conditions. This, in turn, tends to prevent uniform feeding of coal to the mills, especially when feed is reduced during light loads.

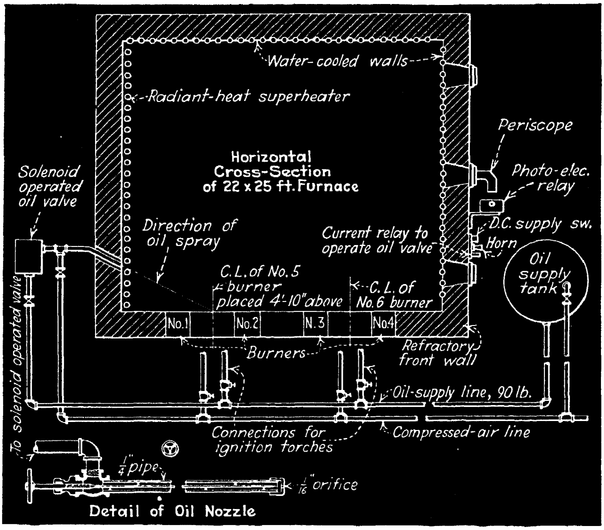

FIG. 24.—Photoelectric cell reoperates igniter until coal catches.

As shown on the right (Fig. 24), a periscope or angle mirror directs light rays from the furnace at a right angle on to the photoelectric cell. The direct-current supply switch, a horn, and magnetic contactor, the last for the solenoid on the oil valve, are mounted on a panel on the boiler casing adjacent to the relay. For the oil-nozzle opening, a ¾-in. pipe was placed at the proper height and angle in an inspection port in the furnace wall, and the opening bricked up. The oil burner, consisting of a ¼-in. pipe with an orifice on the inner end, is pushed through the ¾-in. pipe level with the inner face of the furnace wall.

To prevent failure of the device due to plugging of the nozzle with dirt or carbonized oil, a small rod with suitable guides and a long needle point is inserted in the ¼-in. nozzle connection. This small rod is attached to the stem of a ¼-in. angle valve. Once every 24 hr. the needle point is pushed through the small orifice and withdrawn by turning the valve stem.

The oil connection to the valve is taken from the header supplying the hand torches used in the furnace when lighting up from a cold start. A compressed-air connection is also made to the orifice pipes to permit blowing the pipe clear of oil after each operation.

Cleveland, Ohio. R. M. Bowser.

83-85. Three Pointers on High and Low Heat Values of Natural Gas.

83. When gas-burner equipment is purchased, capacity should be ample to supply all fuel required to develop the maximum steam output of the boiler. This presupposes use of the low heat value of the gas (value established by eliminating heat developed by its hydrogen content).

84. On the other hand, in laying out boiler heating and superheater surfaces, as well as the gas passages through them, one must not disregard the fact that the hydrogen content will increase the quantity of combustible gases passing from the furnace through the boiler setting. The same is true in designing a natural-draft stack or induced-draft fan equipment for gas fuel. In other words, one must take into consideration the fact that the hydrogen in the fuel gas goes through the process of combustion and that the resulting gases must pass through the boiler and be emitted through the stack.

85. Probably one reason that naturally inherent high boiler efficiencies are secured with natural-gas fuel is the fact that the gas over long periods is of uniform composition and quality even though the supply may come from several wells in the same field. Operators soon learn to utilize this practically constant fuel at its maximum efficiency by decreasing excess air to a minimum. However, one should not be deceived if the efficiency figures are high, because they probably have not been corrected for the hydrogen in the fuel. Engineers are not in the habit of correcting efficiency figures for hydrogen content when coal and fuel oil are used, because it is a small amount. In natural gas, where hydrogen not only occurs in combination with other elements but also occurs free, it represents a larger part of the fuel used.

New York, N. Y. W. S. JOHNSTON.

86. Furnace Doors for Explosion Relief.

Serious accidents have resulted from firebox explosions or flarebacks in boiler furnaces equipped to burn oil, pulverized coal, or gas. Boiler settings of these types usually include a number of cast-iron cleanout doors. It will in most cases be good practice to remove the latches from these doors, or at least from the larger ones, to prevent them from being latched shut. The hinges may be adjusted with just enough friction so that slight positive furnace pressures will not cause them to open. If a serious flareback occurs, they will open instantly and relieve the furnace of the excess pressure.

Milford, N. J. HARRY M. SPRING.

87. Lift Doors Better.

A plate that lifts in a horizontal plane, I have found, gives more ready relief than if hinged at one side. If relief doors can be placed only on the sides of the furnace, they must necessarily be hinged, but most boilers of any type have a flat surface somewhere at the top, where a horizontal plate can be installed. Distance from the fire chamber does not seem to make any difference, but losses from radiation are naturally less at a distance. The relief doors on the escape shaft of a coal mine are frequently a mile or more from the scene of an explosion, but they always act promptly.

St. Louis, Mo. L. R. BAKER.

88. Stack-base Damper Improves Combustion Control.

Our boiler plant has four boilers, and the stack has been designed to operate these boilers at 200 per cent rating. Two boilers have so far been sufficient to carry the load. When operating under this condition, the stack has considerable reserve capacity. To make use of this and at the same time to improve ventilation in the boiler room, a damper was installed in the stack base.

This damper is operated automatically by a regulator which causes it to close as the boiler uptake dampers open and to open when the uptake dampers move toward closed position. The stack damper is connected so that at no time is it completely closed. Operation of this damper keeps the flow of air from the boiler room fairly constant, with consequent improvement in ventilation. The stack damper also lessens uptake-damper travel necessary if all combustion regulation were done by them. This feature allows closer control of combustion and a more constant draft on the fire than is possible with uptake dampers alone. To reduce the distance through which the dampers must travel to provide a given change in air flow, those in the boiler uptake and in the stack base are in two sections.

Brooklyn, N. Y. JOHN A. SETHER,
Chief Engineer, St. George Hotel.

89. Window for Boiler Furnaces.

To render looking into furnaces agreeable, thus insuring constant watching, sights can easily be attached at proper points.

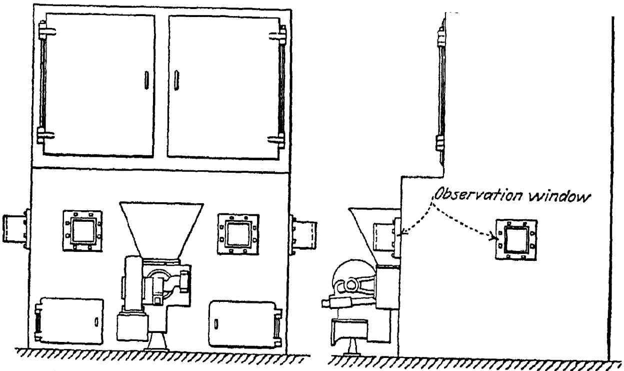

FIG. 25.—Observation windows attached to furnace wall.

These sights are made away from the wall as a casting or fabricated metal extension, bolted to the wall, with a heavy glass plate at the end through which one can peer into the furnace without exposure to heat.

Figure 25 shows how this can be accomplished. The glass can be made removable if desired, and the opening used for operation of tools, etc.

Pittsburgh, Pa. L. G. JONES.

90. Low Pressure in Boiler Room Caused Combustion Trouble.

A minus pressure in the boiler room is quite prevalent; this, of course, exists generally without the knowledge of the operating force. In order to overcome it, an air-inlet opening should be left, to be closed by a swinging door which cannot be locked shut but which will stand normally in such a position. When there is a minus pressure in the boiler room, these swinging doors will open.

When one regards the enormous quantity of air required for combustion, it may be considered remarkable that so few troubles are experienced on account of insufficient air in boiler rooms. Large central stations, of course, take care of this condition by providing regular air ducts with doors swinging inward.

In some large steam plants, it is necessary to warn the operators against closing off the ventilating system during the winter months, which they will invariably do in order to prevent reverse air currents or flow of outside air into the plant, with consequent discomfort to the operators.

Louisville, Ky. JOHN F. HURST.

91. Burning Blocks to Create Boiler Air Space.

When we installed a steam boiler in a small isolated station, the setting plans called for an air space on top of the boiler between the shell and the brick covering. The problem was solved by cutting a number of dry 2- by 6-in. soft wood blocks 1 in. thick, soaking them with kerosene, and then placing two layers of the blocks loosely over the boiler-shell top, as in Fig. 26. Tar paper was placed on top of the block layers to catch drips

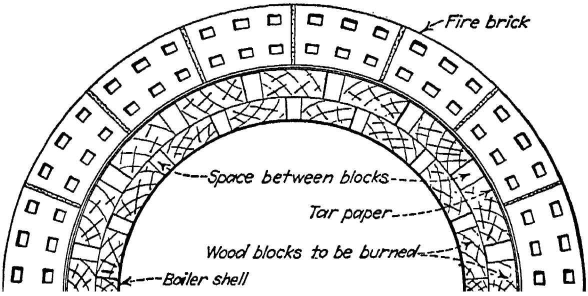

FIG. 26.—Air space on top of boiler is created by burning out the blocks.

from the mortar on the bricks. Firebrick was laid on top of the blocks. After the mortar hardened, the blocks were set afire, and the air space burned out. A blower off a forge forced in air and blew out cinders.

Salem, Mass. G. F. HARDEN.

92. Templet for Checking Boiler Cones.

Cones in boilers of naval destroyers are generally molded in place, and considerable trouble has been caused by plastic cracking and breaking off.

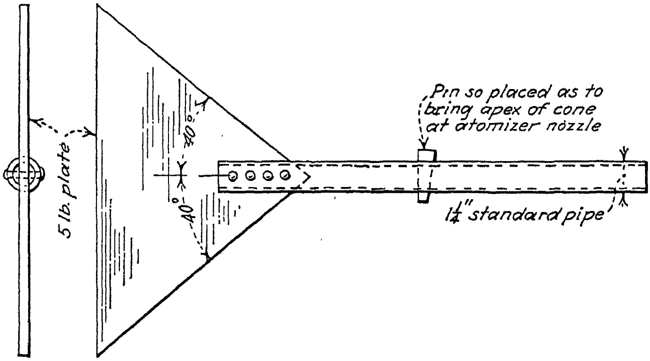

FIG. 27.—Templet for checking angle of burner cone.

This was improved by using only firebrick, shaping the cones by breaking the ends of the brick and grinding to shape. A light layer of plastic was then applied. Trouble was encountered because there was no method of checking the angle of the cones made this way, and on numerous occasions it was found that the angle was off the center of the opening.

The spray templet shown in Fig. 27 was made at a small cost for material and labor and has given good results.

Boston, Mass. EARLE S. NASON,
Chief Machinist, U. S. Navy Yard.

93. Close Damper Regulation Made Possible.

The boiler room of a certain plant was equipped with seven 2,500-sq. ft. water-tube boilers all connected to a common breeching. Five boilers were operated by automatic stokers, and two were oil fired.

The dampers in the throat between each boiler and the breeching were operated by wires attached to the lever on the damper rods. This did not lend itself readily to correct adjustment of the damper for the combustion conditions existing in each boiler.

This condition was remedied as follows: A worm gear and bracket were attached to the damper rod and worm on a length of rod run down to the floor within easy reach of the fireman (Fig. 28). To the end of this rod a handwheel was fastened and a bracket placed just above it and attached to the boiler front to keep the whole setup rigid.

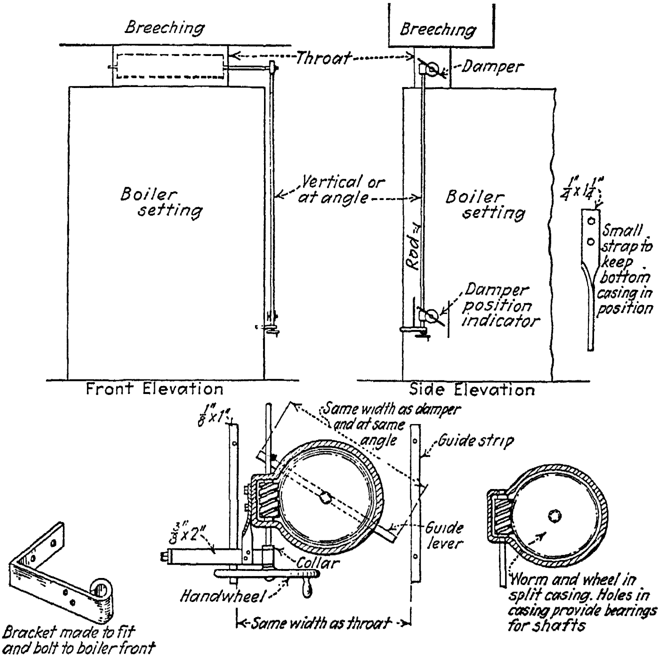
Breeching
Breeching
Throat
Damper
Vertical or at angle
Boiler setting
Boiler setting
Rod ¾"
Damper position indicator
¼"x1¼"
Small strap to keep bottom casing in position
Front Elevation
Side Elevation
⅛"x1"
Same width as damper and at same angle
Guide strip
⅜"x2"
Guide lever
Collar
Handwheel
Same width as throat
Worm and wheel in split casing. Holes in casing provide bearings for shafts
Bracket made to fit and bolt to boiler front

FIG. 28.—Rearrangement of controls makes close damper regulation possible.

Above this second bracket another set of worm gearing was placed. This had the same ratio as the set attached to the damper. To the spindle of the worm gear in this case, however, was attached the lever taken from the damper rod. This lever was attached so that it was parallel to the damper, and two strips attached to the boiler setting indicated or represented the throat of the breeching. When the handwheel was turned, the motion was transmitted to the damper and to the position-indicating lever simultaneously.

Irvington, N. Y. JAMES R. KNOX.

94. Operation of Balanced-draft Control Materially Improved.

We made changes in the arrangement of our balanced-draft equipment which have materially reduced the attention required and improved the operation.

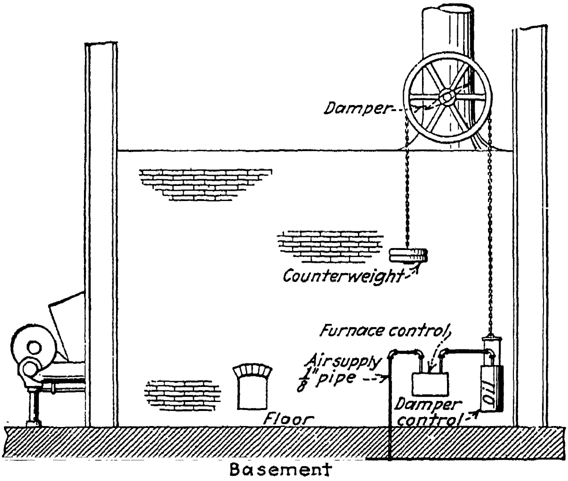

FIG. 29.—Balanced-draft control after the changes.

Damper shaft bearings had been built in the sides of the uptake. In this position, they were always hot and could not be lubricated. To reduce the friction at this point, the shaft was made longer and fitted with roller bearings placed away from the heat where they could be properly lubricated. The pulley on the damper shaft was also increased from 18 to 30 in. (Fig. 29). This change, in addition to reducing friction on the damper shaft, made it possible to reduce air pressure from 20 to less than 10 lb. We also changed from water to oil in the damper control and relocated the furnace control as near to the damper control as possible, so that the latter would respond more quickly to any changes in the furnace or combustion-chamber conditions.

Since these changes, we can average 0.05 to 0.08 in. overfire draft with 150 per cent rating on the boiler. We add a little oil to the damper control twice a week.

Winchester, Mass. JOHN C. CASLER,
Chief Engineer, Beggs & Cobb.

95-100. Six Pointers on Damper Regulation.

95. Complete combustion and efficient operation depend both upon amount of air admitted and manner in which it is admitted. It would be hard to determine which causes more waste: too much air admitted, causing heat loss in the dry stack gases; or too little air, causing unburned fuel to escape as CO and unburned carbon. Improper damper control can cause either or both of these losses.

96. Heat loss from excess air may be determined by computing the heat loss in the dry stack gases for different percentages of excess air. This may be done by multiplying the specific heat of flue gases, 0.24, by the difference in temperature between the flue gases and the atmosphere and then multiplying this product by the weight of the flue gases in pounds.

97. Losses from insufficient air are serious, since every pound of carbon in the ash means a loss of approximately 14000 B.t.u., the heat value of a pound of carbon burned completely to CO_2. If the carbon is burned to CO, the heat loss is about 70 per cent as much, or 9800 B.t.u. per pound, because only 4200 B.t.u. out of the 14000 is released. CO losses are likely to be as great as carbon losses and much harder to detect and cure, for they are not evident by casual inspection, like the loss from carbon in the ash, but only by flue-gas study and analysis.

98. Where several boilers operate on one stack, there should be a damper in the uptake of each boiler, with a main damper in the flue near the stack. The damper in each uptake makes it possible to regulate draft in the individual furnace to suit that particular boiler.

Regulation of the rate of steaming of the battery is accomplished with the main damper. Where load is steady, the main damper may be set to give proper draft and will seldom have to be changed. No two boilers in a battery represent exactly the same requirements, for the reason that the location relative to the stack alone is sufficient to cause a difference in draft. The steam lines perhaps are not identical, causing steam to be drawn from one more freely than the other, or the setting of one may admit more air than another. These differences make it necessary to regulate the draft of each boiler independently of the others.

99. Bituminous coal contains a large percentage of hydrocarbons that are driven off quickly after the coal is thrown on the fire. To consume these gases properly, a large amount of air should be admitted at this stage of firing. After the coal has become coked, less air is needed. The main damper in the stack controls the time and duration of increased or decreased draft according to the steam pressure, while the individual dampers are regulated to suit the general requirements of each boiler.

100. Even where there is but one boiler, proper firing requires constant watching to get best results. For this reason, automatic fuel, air, and damper controls are desirable. Where artificial draft is used, it is best that blower speed be changed with variation in steam pressure. Where load varies widely, fuel feed also should be automatically controlled.

Mission, Tex. R. H. PARRISH.

101. Pointers on Breeching Areas.

Improperly designed breechings are to blame for poor economy, in many instances the breeching connection being too small to provide the necessary area for free escape of the burned gases from the boiler.

A test showed efficiency of a water-tube cross-drum boiler and furnace low. We decided to enlarge the breeching between the setting and stack and got greater output of steam with a considerably smaller consumption of fuel. Chimney draft had been fairly good, but the restricted breeching introduced too much resistance to the flow of gas between boiler and stack. Discovery of such a condition is facilitated by having a double connection for the draft gage, one branch running to the furnace and the other to the base of the stack or chimney.

Two return-tubular boilers were connected to the same horizontal breeching, but the space into which the chimney gases passed directly from the uptake of boiler 2 was contracted by the tapered end of the breeching. As a consequence, boiler 1 did most of the work when the dampers had equal opening. By careful adjustment of the damper above boiler 1, the two boilers could be made to work uniformly but not without almost constant attention. Removing the tapered portion and carrying the breeching out full size remedied the difficulty.

In computing the requisite size for a breeching, some engineers use the rule-of-thumb method of allowing 3.5 sq. ft. of cross section per 1,000 sq. ft. of boiler heating surface. This is all right if the computation gives the net, or effective, area. If the breeching is round and straight and entirely unobstructed throughout its length, the gross area also will be the net area. But where short turns and angles are necessary in the breeching construction, allowance must be made in figuring the actual net area. It is quite probable that the cross sections of many breeching connections in use would have to be expanded as much as 20 per cent to give the required net effective area.

St. Louis, Mo. D. J. Allison.

102. Convenient Manual Control for Boiler Damper.

Automatic stokers were installed in a boiler plant, but because the load was fairly steady, air supply to the furnace was con-

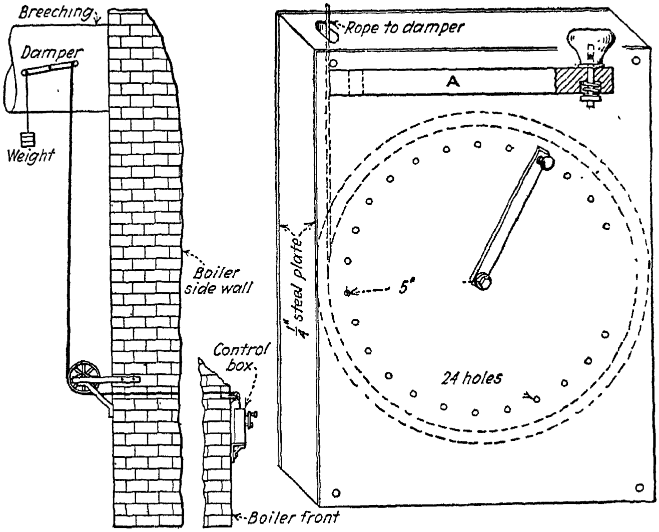

Fig. 30.—Convenient manual control for a boiler damper.

trolled manually by adjusting the setting of the damper in the breeching. Usually, it required two or three trips back of the boiler to adjust the damper.

To permit adjustment of the damper at the boiler meter, a controller was mounted on the boiler front below the boiler meter as in Fig. 30. The essential part of the control is a flanged pulley on which the damper rope is wound. The pulley is mounted in a metal case and turned by a lever, as at right. To make close adjustments of the damper, 24 holes were bored in the front plate of the control case. As shown at *A*, a pin is attached to the knob on the control handle, the end of this pin fitting into the holes in the front plate to hold the damper in position.

Chicago, Ill. M. E. WAGNER.

103. A Suggested Improvement.

There is an objectionable feature to the method of Fig. 30, for if the control wire should break, which is quite probable, the damper would be shut by the weight. A better method would be to key two pulleys on the damper shaft, one pulley actuated by the control wire and the other by the weight rope, as in Fig. 31. With this arrangement the weight tends to open the damper, and the control wire to close it. Then if the control wire breaks, the damper will be opened by the weight.

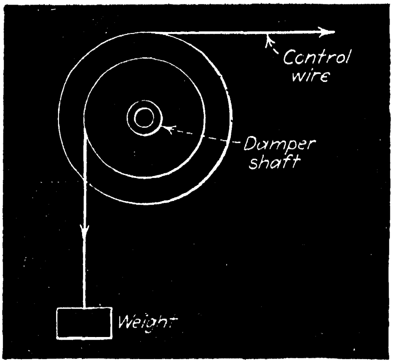

FIG. 31.—Improvement on Fig. 30, by which weight shuts damper if control wire breaks.

Chicago, Ill. S. E. NICHOLS.

104. Stop Air Leakage with Flap Dampers.

Figure 32 shows a type of cast flap damper we made to prevent air leakage past the rear end of our chain-grate stokers. These dampers are 4 in. wide and are suspended from the return line from the water backs. The lower end of the dampers rest against the grate as shown. The dampers are made with webs on their sides to permit them to swing past each other without producing an opening. This construction allows any damper to open as much or as little as necessary to pass whatever the grate brings to it without affecting the other dampers. The object of the web was to keep the air shut off and to prevent distortion.

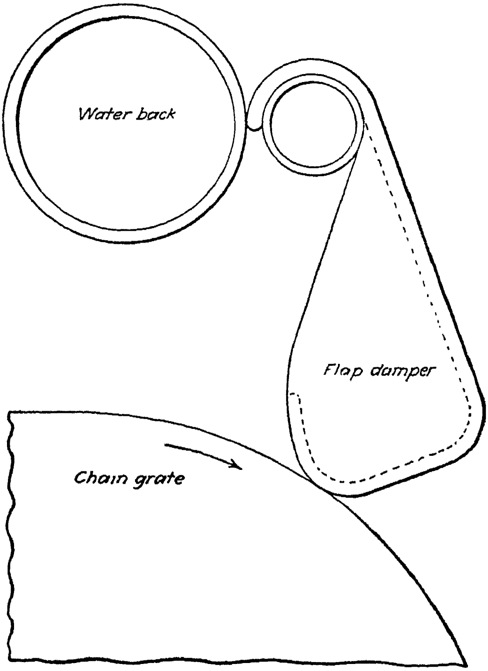

Fig. 32.—Arrangement of dampers at rear of chain grate.

The first dampers put on were turned with the pocket from the fire. They held their shape, but holes burned through the backs quickly. On the next set, the pockets were turned toward the fire. These filled with ashes and protected the dampers.

Elgin, Ill. W. L. Parker.

105. Stopping Air Leakage.

Our plant is equipped with stoker-fired water-tube boilers. We had never been able to obtain the efficiency that we expected.

Finally, the management was persuaded to get a CO_2 apparatus and through this found that excess air was over 50 per cent.

As the setting was tight, we were at a loss to locate the leakage until by chance we discovered that the air came through at the end of the traveling grate. The coal we use has a fine ash, and this would not pile up under the stoker to reduce the air flow on light loads when the rear end of the stoker was more or less bare.

The trouble was corrected by rebuilding the bridge wall with an overhang extending out over the end of the stoker a distance of 12 in. This does not interfere with the ash on heavy loads and does largely reduce air leakage on light loads.

Newark, N. J. S. Abrams.

106-107. Two Ways of Making Homemade Refractory Dead Plates.[1]

The ordinary cast-iron dead plate used under a h.r.t. boiler is subject to warping and breakage, since it is exposed to high temperature. These dead plates must frequently be replaced. Figure 33 shows two practical methods of building permanent refractory dead plates.

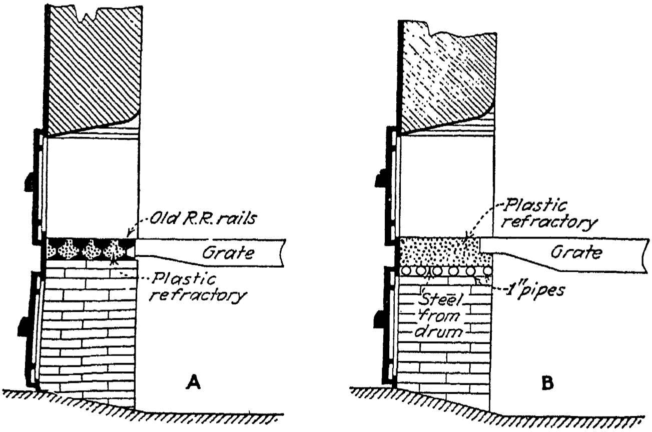

FIG. 33.—Two methods of making plastic firebrick dead plates.

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[1] Copyright 1928, by Plibrico Jointless Firebrick Co.

106. At *A*, the dead plate is constructed of old railroad rails cut to proper length to span the ashpit and rest on the side brickwork, with the spaces between rails filled with plastic firebrick. If the rails available are much deeper than the end of the grate, it will be found advisable to use an angle iron for the grate to rest on.

107. In sketch *B*, the dead plate is constructed of pipes not smaller than 1 in. in diameter, which span the ashpit. These pipes are then covered with the steel sheet of the container in which the refractory is shipped. Over this base, 5 or 6 in. of plastic furnace lining is pounded in. An angle iron should be inserted to carry the end of the grate. When baked out, plastic firebrick gives a monolithic, one-piece dead plate.

Chicago, Ill. K. B. WILT.

108. Smoke-preventing Furnace for Horizontal Return-tubular Boilers.

Every inch of height above the grate is significant for smokeless combustion. Owing to the fact that it is not always possible or practical to raise the boiler, it is expedient to make an inclined dead plate and lower the grate. In most cases, this adds 8 to 10 in. in height from the grate to the surface of the boiler. Besides increasing the volume of the furnace, the inclined dead plate makes it much easier to see the whole grate and to maintain an even thickness of fuel bed. Inclined dead plates are also applicable to furnaces of water-tube boilers. In all cases, an increase of efficiency of 2 to 5 per cent is possible.

Harbin, China. M. F. KOCHERJINSKY.

109. Butterfly Valve Obviates Soot Troubles.

We had trouble finding a suitable valve for the soot lines of a water-tube pulverized-coal-fired boiler. Soot transport lines empty into the ash sluiceway, which is always damp (Fig. 34). The soot would cling to the side of the pipe and build across the bottom. This would rapidly cause sweating in the pipe, and within a short time the line would become clogged. A butterfly valve was installed about 7 ft. above the outlet with the rod of the valve hanging vertically when the valve was closed. An arch cut in the pipe above the floor level sets up a current of air across the outlet, which prevents the damp air and condensate from settling on the pipe and clogging it.

Soot from the hopper is dumped into the sluiceway twice in each shift, the operator merely holding the valve in the open position. He can see that the soot is running by looking down at the arch in the bottom of the pipe. After all soot is out of the hopper, he lets go of the handle, and it falls closed. Soot quickly accumulates on the butterfly valve after cleaning and forms a good seal against any leakage of air into the furnace.

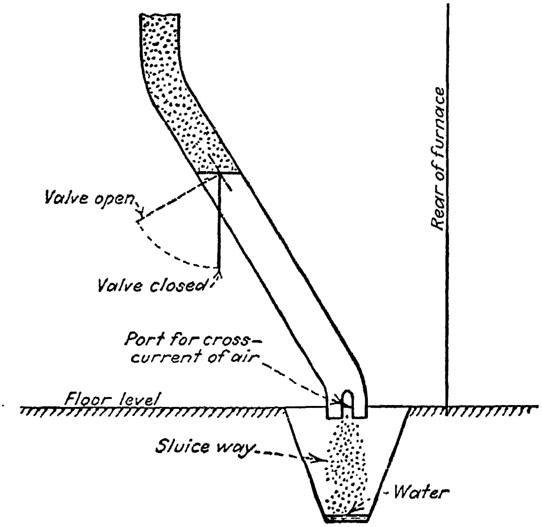


Fig. 34.—Soot-hopper pipe fitted with butterfly valve and air vent.

A 1-in. mesh wire screen is placed about 8 in. above the bottom of the soot hopper to catch any broken pieces of brick which might get into the pipe and clog it.

Holtwood, Pa. M. W. Horley,
Boiler Room Engineer, Holtwood Power Co.

110. High Flue-gas Temperature.

High flue-gas temperature may be caused by soot on the outside of the boiler tubes or scale on the inside water surface, poor water circulation after burning of the combustion gases, broken or leaky baffles, and high excess air.

111. Not Air Flow but Gas Flow.

It is time that the old misnomer "air flow" used in connection with differential draft in the gas passages of boiler furnaces be discontinued and that the correct name "gas flow" take its place.

Chicago, Ill. LEWIS M. ELLISON.

112. Construction of Flue-gas Analysis Chart.

The perfect-combustion line is established by first determining the maximum possible CO_2 content of the flue gas. This condition is attained with zero excess air and is determined in the following manner:

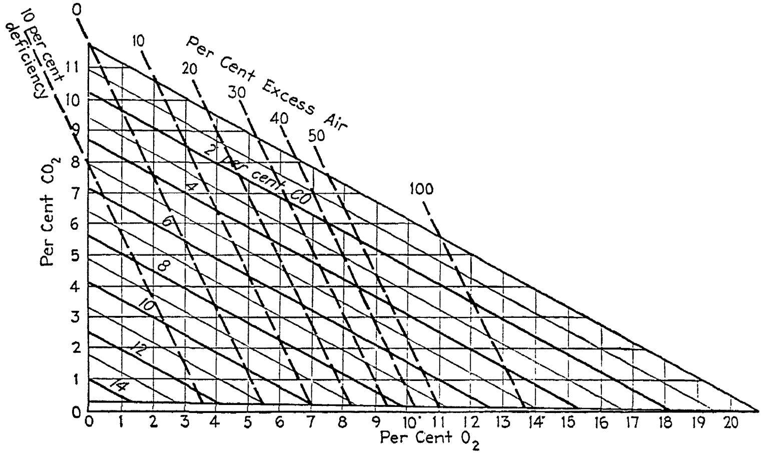


FIG. 35.—Flue-gas analysis chart.

Fuel Constituents, Mols — Products of Combustion, Mols

$$\begin{array}{lr}
0.965CH_4 + 0.965(2)O_2 + 0.965(2)(3.78)N_2 & \\
\quad = 0.965CO_2 + 2(.965)H_2O + 7.3N_2 & \\
0.021N_2 & = 0.021N_2 \\
0.014CO_2 \quad = 0.014CO_2 & \\
\hline
1.0 \text{ gas} + (1.930_2 + 7.3N_2) = 0.979CO_2 + 1.93H_2O + 7.321N_2 & \\
\text{Fuel} \quad + (\text{Air}) = \text{products of combustion} &
\end{array}$$

The Orsat analysis gives the analysis of the dry products of combustion; therefore the maximum percentage of CO_2 will be

$$\frac{0.979CO_2 \times 100}{0.979CO_2 + 7.321N_2} = 11.8 \text{ per cent}$$

This value of CO_2 establishes the upper chart corner (Fig. 35) and also is one end of the zero excess-air line. The lower right-hand corner of the chart gives the analysis of dry air, that is, no CO_2 and 20.9 per cent O_2. The perfect-combustion line is drawn between these two points.

Slope of the Excess-air Lines. The other end of the zero excess-air line is determined by computing the Orsat analysis for the worst case of imperfect combustion, that is, where none of the active constituents of the fuel burns to CO_2, thus:

$$\begin{aligned}
&0.965CH_4 + 1.93O_2 + 7.3N_2 = 0.965CO + 1.93H_2O + 0.428O_2 \\
&\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad + 7.3N_2 \\
&0.021N_2 \qquad\qquad\qquad\qquad\qquad\qquad\qquad = 0.021N_2 \\
&0.014CO_2 \qquad\qquad\qquad = 0.014CO_2 \\
\hline
&1.0 \text{ gas} + 9.23 \text{ air} = 0.014CO_2 + 0.965CO + 1.93H_2O \\
&\qquad\qquad\qquad + 0.482O_2 + 7.321N_2
\end{aligned}$$

The resulting Orsat analysis will be

$$\frac{0.014CO_2 \times 100}{0.014CO_2 + 0.965CO + 0.482O_2 + 7.321N_2} = 0.16 \text{ per cent } CO_2$$

$$\frac{0.482O_2 \times 100}{8.782} = 5.5 \text{ per cent } O_2$$

$$\frac{0.965CO \times 100}{8.782} = 11 \text{ per cent } CO$$

These values, when plotted, determine the lower end of the zero excess-air line. Also, a line drawn from the lower right-hand corner through this point determines the sloping base line.

The CO lines are evenly spaced and are drawn parallel to the perfect-combustion line. The spacing is such that the 11 per cent line passes through the last point calculated above.

The excess-air and deficiency-of-air lines are parallel to the zero excess-air line so that they may be drawn as soon as one point is located on each. A point on the perfect-combustion line, for 20 per cent excess air, may be located in the following manner (refer to first calculation):

$$\begin{aligned}
&1.0 \text{ gas} + 1.2(1.93O_2 + 7.3N_2) \\
&\qquad = 0.979CO_2 + 1.93H_2O + 8.781N_2 + 0.386O_2
\end{aligned}$$

therefore

$$\frac{0.979CO_2 \times 100}{0.979CO_2 + 8.781N_2 + 0.386O_2} = 9.75 \text{ per cent } CO_2$$

and

$$\frac{0.386O_2 \times 100}{10.146} = 3.80 \text{ per cent } O_2$$

These values of CO_2 and O_2 locate a point on the 20 per cent excess-air line and on the perfect-combustion line and therefore permit the line to be drawn. The other lines may be located in a similar manner, and the chart is then complete.

Atlanta, Ga. NEWTON C. EBAUGH.

113. Formula for Heat Loss in B.t.u. per Pound of Dry Flue Gas.

The proper way to find the weight of flue gas per unit of time or per pound of fuel burned is to analyze the flue gas and eliminate the guesswork. A simple formula for finding the weight of flue gases per pound of dry coal and one that the new engineer as well as the old understands is given under formula (1):

$$W = \frac{11 \times CO_2 + 8 \times O_2 + 7 \times (CO + N)}{3(CO_2 + CO)} \times C \qquad (1)$$

in which CO_2, O_2, CO, and N_2 are the percentages by volume of these gases in the flue gas as found by analysis, and C equals the weight of carbon in 1 lb. of coal as found by ultimate analysis. All percentages are to be expressed decimally. The weight of flue gas having been found, the loss can be found by formula (2).

$$L = 0.24W[T - t] \qquad (2)$$

where L = heat loss per pound of dry coal in B.t.u.
0.24 = specific heat of flue gas
T = temperature of flue gases where they leave the heating surface
t = temperature of air entering fuel bed

Assume a flue-gas analysis of the following values: $CO_2 = 14$ per cent, $O_2 = 4$ per cent, CO = 0.2 per cent, N = 81.8 per cent, and C = 78 per cent.

What is the weight of gas per pound of dry coal [using formula (1)]?

$$W = \frac{11 \times 0.14 + 8 \times 0.04 + 7 \times 0.002 + 0.818}{3 \times 0.14 + 0.002} \times 0.78$$
$$= 13.92 \text{ lb.}$$

If, in this same case, the weight of gas = 13.92 lb. per pound of dry coal, the temperature of the gas at the last pass = 500°F. The air entering the fuel bed = 80°F. What is the loss per pound of dry coal [applying formula (2)]?

$$L = 0.24 \times 13.92 \times (500 - 80) = 1403 \text{ B.t.u. per lb.}$$

We can safely assume that any power plant that cannot get hold of an Orsat to analyze its flue gas is not worrying about how much heat goes up the stack.

Des Moines, Iowa. HARRY STUART.

114. More on Loss in Flue Gases.

May I suggest that engineers modernize their methods of treating the above and other similar problems?

The problem is much simpler if done in mol quantities and requires no long formula. Take the analysis Mr. Stuart cites: CO_2, 4 per cent; O_2, 4 per cent; CO, 0.2 per cent; and N_2, 81.8 per cent in the dry gas. The dry coal contains 78 per cent of carbon.

In a cubic foot of flue gas, the molal quantity of carbon is $0.142 \div 380 = 0.000374$. The weight of carbon is

$$0.000374 \times 12 = 0.00448 \text{ lb. per cubic foot of dry gas.}$$

Therefore, the volume of gas per pound of dry coal is

$$\frac{0.78}{0.00448} = 17.4 \text{ cu. ft.}$$

Since the mean specific heat of flue gas is approximately 0.0195 B.t.u. per cubic foot in the range of 500°F., the heat loss per pound of dry coal is $174 \times 0.0195(500 - 80) = 1425$ B.t.u.

Mr. Stuart has overlooked another item, if accuracy is desired, and that is the sensible heat of the H_2O vapor from the hydrogen contained in the dry coal. This usually runs 5 per cent, or 0.05 lb. of hydrogen per pound of coal. Since the weight of hydrogen in a cubic foot of H_2O is $2/380 = 0.00527$ lb., the volume of water vapor is 0.05/0.00527 = 9.4 cu. ft. per pound of coal, and the heat loss due to H_2O vapor is

$$9.4 \times 0.0233(500 - 80) = 105 \text{ B.t.u.}$$

Therefore, the total sensible heat going out the stack is 1,530 instead of 1,403, as Mr. Stuart solves.

Linden, N. J. V. F. PARRY,
Combustion Utilities Corporation.

115. Can a CO_2 Record Indicate a Cracked Baffle?

Can a CO_2 record indicate a cracked baffle? Common opinion is: "The best way to detect a broken baffle is with a thermometer or temperature recorder in the stack or breeching."

Perhaps—but with certain types of firing equipment, such a short-circuiting of gases in the boiler may increase the furnace draft to the extent that the excess air induced will lower the exit-gas temperature considerably. In fact, uptake temperatures are affected so greatly by the amount of excess air that without draft gages the temperature indicator or recorder is far from sufficient in itself.

It is my opinion that a two-reading draft gage showing both furnace and uptake drafts tells the truest story concerning the condition of boiler passes.

The relative position of the two draft indications pictures the differential or draft loss through the boiler (best shown by two pointers on a common scale.) A short-circuiting of gases through faulty baffling decreases the differential and is shown by the two pointers being relatively close together. Conversely, a restriction of passes through fouling causes greater resistance and more differential, as shown by two pointers being farther apart than normal.

Thus the draft gage is necessary to the pyrometer installation on boiler uptakes as well as essential with the CO_2 recorder. The draft gage immediately indicates and interprets a low CO_2 reading as due to either an insufficient air supply by showing too little draft or an overabundance of air from too much draft.

River Forest, Ill. WALTER T. RITTER.

116. A Continuous Gas Sampler.

In this sampler, the rate of discharge on the water is constant at all times, thus giving a true average sample. We want an average over a week's time, and we find that this tank gives a satisfactory sample, and when we want a 24- or 8-hr. sample, it is necessary only to change the rate of discharge.

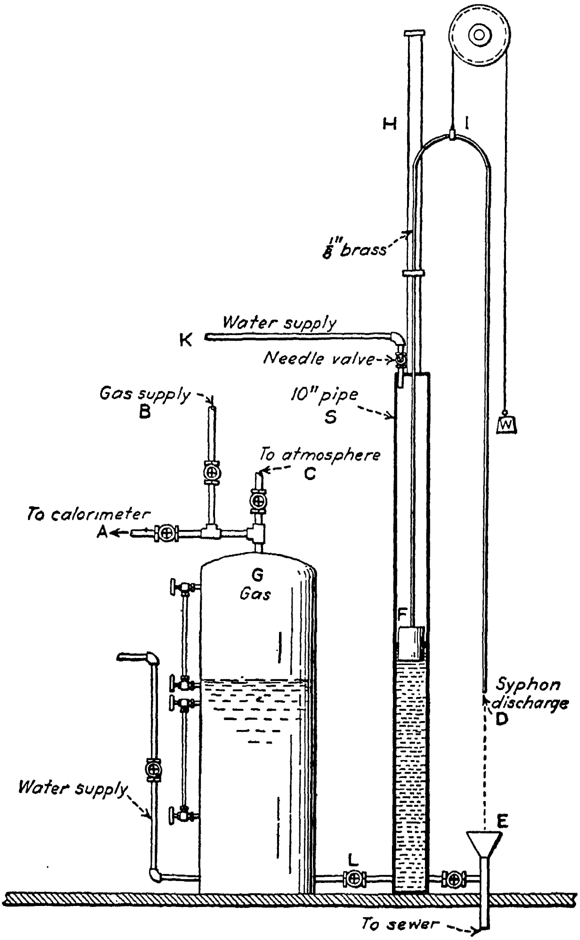


FIG. 36.—Arrangement of gas sampler.

We use a round galvanized-iron tank 7 ft. high and 30 in. in diameter. The letters in Fig. 36 show the method of operation as follows: *A*, gas connection to calorimeter; *B*, gas connection from the gas supply; *C*, valve which can be opened to the atmosphere and the tank completely filled with water; *D*, discharge of the siphon (this siphon is made of ⅛-in. brass pipe and is attached to the float *F* and counterbalance *W*, giving a constant discharge of water from the standpipe *S*, which is cross-connected to the main gas holder *G* by pipe *L*); *E*, funnel to carry the discharge water to the sewer or hot well; *F*, copper float which fits loosely in the 10-in. standpipe (the float is approximately 10 in. in diameter and 12 in. high, with the siphon inlet at the bottom); *H*, guide rail for the siphon to slide on.

Water supply to the standpipe *S* is regulated by a needle valve. The rate of the water entering the standpipe determines the net time required to empty the tank. In our case, for one week's operation, the siphon discharges 2½ lb. of water per minute, while inlet *K* puts 2¼ lb. back in the standpipe, leaving the net discharge ¼ lb. per minute. With ordinary care, this sampler gives satisfactory results and a truly representative sample.

Kansas City, Mo. PAUL SPEER.

117-120. Four Principles of Installing Water Walls.

Principles on which the decision of whether or not to use water walls should be based are:

117. Protection of refractories is, of course, the ultimate desire, but along with this goes ease of operation, such as cleaning fires and maintaining a proper fuel bed. The function of water walls is to lower the temperature of the furnace or of the material adjacent to them. This lower temperature may be desired locally, as in the case of side and rear walls of a multiple-retort stoker or the arches and side walls of a chain-gate stoker. Lower temperature may be desired generally throughout the furnace to prevent formation of clinker in the fuel bed of a stoker, to prevent formation of slag in a pulverized-coal furnace, or to prevent slagging of fly ash, which may close up the passage between the boiler tubes in either a stoker or a pulverized-coal fired boiler.

118. If local protection is required for a stoker-fired furnace, then water cooling should be applied at such points as are exposed to clinker formation, such as side and rear walls of an underfeed stoker, and only that region subjected to clinker formation should be covered. Here it is a case of providing a cold surface to which clinker will not stick, and little heat is absorbed by such surface.

119. If the nature of the installation is such that the temperature of the furnace limits the rating, then water-cooled surface should be applied to reduce this temperature to or slightly below the fusion point of the ash. It, of course, becomes an economic question whether to provide more boilers to operate at lower rating or to install water walls to permit higher ratings on fewer boilers.

120. Each installation is a problem in itself, and no general rule based on horsepower, rating, or furnace volume can be applied. Factors that enter the computation are the amount of radiant heat-absorbing surface exposed, the fusion point of the ash, the amount of heat released in the furnace, and the excess air used.

Furnace volume enters the problem only in so far as the proper size and shape of furnace is provided to complete combustion within the furnace limits. Many cases are on record of ample furnace volume being provided, without sufficient heat-absorbing surface exposed to the fire, so that excessive temperature resulted, limiting the rating or causing inefficient operation.

Worcester, Mass. JAMES W. ARMOUR,
Engineering Manager, Riley Stoker Corporation.

CHAPTER II

FEED WATER—HANDLING, TREATING, AND HEATING

121-124. Four Pointers on Feed-water Purification Systems.

121. I took charge of a raw-water ice plant where water supply contained 50 gr. of calcium and magnesium salts to the gallon. As zeolite softeners do not yield clear ice without special treatment, a small lime-alum plant had been installed, which the chief engineer told me was no good and pointed to the ice as proof.

I tested hardness, increased the lime charge about 20 per cent, and discarded the alum. Then I put a small shelf alongside of the filter and placed a 150-cc. beaker and a weak solution of phenolpthalein in a bottle with a medicine dropper through the cork. Every few hours I drew the beaker half full of filtered water, added 2 drops of phenol, and shook the beaker. The engineer watched this but said nothing for two days, then volunteered that the ice was coming through like glass, and asked me what to do if the test showed clear or very pink. Eventually he asked me to show him the soap and methyl orange tests. He knew "how" but not "why."

122. My advice to small-plant operators is: Build a water softener if you cannot afford to buy one. An ordinary wooden tank or an old boiler with an agitator or a pump will do. Mix a bag of calcium hydrate (slaked lime) in a barrel of water and pump the milk of lime into your tank. Let it settle and try the test referred to. If very pink, use less lime next time. Get or construct a small sand filter and take the feed from this through your heater or injector.

123. The zeolite system is good in water free from iron salts or where a previous lime softening has been used, but when used on a hard water it leaves as much sodium salts in the feed as there were magnesium and lime salts. These do not scale but do cause foaming if the boiler is not blown down frequently, and blowing down is a waste of heat (and water when the latter is metered).

124. My preference is for a lime-barium-alum combination. The lime takes out the greater portion, the barium takes the rest, and the alum, which should be ammonia alum or aluminum sulphate, removes any excess of barium hydrate (a deadly poison if taken internally). A lime-strontium hydrate would give water comparable to rain water, but if all started using it, the price of strontium hydrate would be prohibitive, if it could be obtained at all.

Chicago, Ill. L. R. Baker.

125. Short Cuts to Water Treatment.

To simplify the work of the boiler-house chemist, particularly those who are chemists part of the time and operators most of the time, the following tables are suggested. They eliminate some calculations.

While not suited for highly accurate determinations, for the usual boiler plant burette they are a help. They concern only acidity of the water and lime treatment for neutralization.

Table I gives directly the acidity of the water for various quantities of standard solutions required to neutralize. While it is based upon standard solutions of one-tenth normality, similar tables could be derived for any normality.

Table I.—Cubic Centimeters of Alkaline Solution Used

C_c	0	1	2	3	4	5	6	7	8	9
	Parts per million acidity									
0	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
10	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
20	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5
30	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
40	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5
50	25.0	25.5	26.0	26.5	27,0	27.5	28.0	28.5	29.0	29.5
60	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5
70	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5
80	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5
90	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5	49.0	49.5
100	50.0	50.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0	54.5

The foregoing tabulation is based on an alkaline solution of one-tenth normal, which would neutralize a sulphuric acid solution make up of 0.005 g. per cubic centimeter. The normality of the standard solution used would depend upon the acidity of the water tested. Greater accuracy would be obtained with water that is almost neutral, by using one-fiftieth normal, and some such more dilute standard than given in the table.

TABLE II.—QUANTITY OF COMMERCIAL LIME TO BE ADDED TO BOILER WATER PER HOUR

Pounds of commercial lime[1] to be added to water per hour to neutralize acid therein

Pounds of water consumed per hour	Parts of acid per 1,000,000 parts of water, by chemical analysis									
	5	10	15	20	25	30	35	40	45	50
100,000	0.41	0.83	1.24	1.65	2.06	2.47	2.88	3.30	3.71	4.12
110,000	0.45	0.91	1.36	1.82	2.27	2.72	3.17	3.63	4.08	4.51
120,000	0.49	0.99	1.48	1.99	2.48	2.97	3.46	3.96	4.45	4.92
130,000	0.54	1.07	1.61	2.14	2.68	3.22	3.75	4.28	4.82	5.36
140,000	0.58	1.15	1.73	2.31	2.89	3.47	4.04	4.61	5.19	5.77
150,000	0.62	1.24	1.86	2.47	3.09	3.71	4.33	4.94	5.56	6.18
160,000	0.66	1.32	1.98	2.64	3.30	3.96	4.62	5.28	5.94	6.59
170,000	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.40	6.30	7.00
180,000	0.74	1.48	2.22	2.96	3.71	4.45	5.19	5.92	6.67	7.42
190,000	0.78	1.56	2.35	3.13	3.92	4.70	5.48	6.25	7.04	7.83
200,000	0.82	1.65	2.47	3.29	4.12	4.94	5.77	6.59	7.42	8.24
210,000	0.86	1.73	2.59	3.46	4.33	5.19	6.06	6.92	7.79	8.66
220,000	0.90	1.82	2.73	3.64	4.54	5.44	6.35	7.25	8.16	9.07
230,000	0.95	1.89	2.84	3.79	4.74	5.69	6.63	7.58	8.52	9.48
240,000	0.99	1.97	2.96	3.95	4.95	5.94	6.92	7.91	8.89	9.89
250,000	1.03	2.05	3.08	4.12	5.16	6.19	7.21	8.24	9.26	10.30
260,000	1.07	2.13	3.20	4.30	5.37	6.44	7.50	8.57	9.63	10.71
270,000	1.11	2.22	3.34	4.45	5.57	6.67	7.79	8.80	10.01	11.12
280,000	1.15	2.30	3.46	4.62	5.78	6.92	8.08	9.13	10.38	11.45
290,000	1.19	2.39	3.58	4.78	5.98	7.16	8.36	9.46	10.75	11.95
300,000	1.24	2.47	3.71	4.94	6.18	7.42	8.65	9.89	11.12	12.36

[1] Above figures based upon 85 per cent active CaO in commercial lime.

Table II gives the quantity of lime of 85 per cent activity that must be used for the average range of water consumption, to neutralize the acid contained therein.

By the use of such charts or tables, placed for ready reference, together with the flow chart showing the rate of water to the boilers, the quantity of lime to be added is readily obtainable.

New York, N. Y. C. W. STEVENS.

126. Parts per Million vs. Grains per Gallon.

In water treatment and analyses, different plants use various units in expressing contents of the water. The two most common units are "grains per gallon" and "parts per million." Besides, there are special terms used, such as "degrees," "per cent," and others.

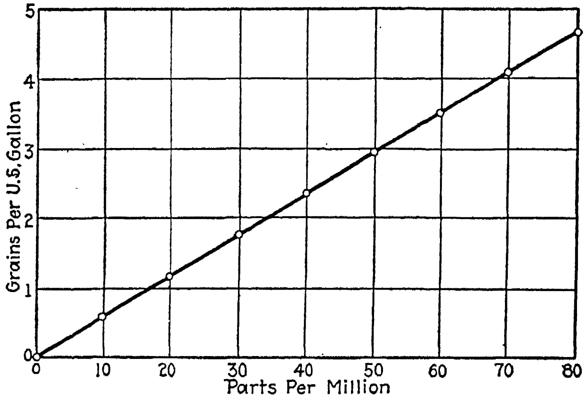


FIG. 37.—Curve shows relationship between grains per gallon and parts per million.

To a novice this is confusing. For the conversion of parts per million to grains per gallon, and vice versa, the curve in Fig. 37 is suggested, as a quick and simple means.

This curve is based upon the relationship:

1 gr. per gallon is equivalent to 17.3 p.p.m.
1 p.p.m. is equivalent to 0.0583 gr. per gallon.

This ratio holds regardless of what constituent or property is under consideration, such as acidity, alkalinity, sulphates, carbonates, hardness, etc., as these terms relate to some common base. Hence, the curve is good for any such conversion.

Cleveland, Ohio. C. W. STEVENS.

127. Complete System for Feeding Boiler Compound.

Boiler chemicals or compounds should be fed to the boiler evenly and continuously in direct ratio to evaporation.

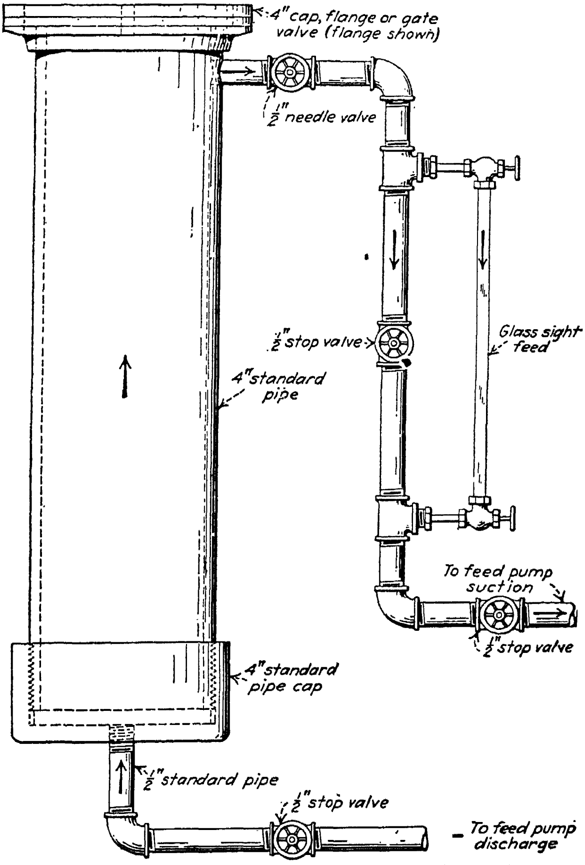


Fig. 38.—Compound-feeding device for chemicals in either solid or liquid form.

The device shown in Fig. 38 is particularly adaptable for chemicals in solid form. For liquids and powdered chemicals, an ordinary drip tank, with a gage glass and a drip cock, will do the trick. The dissolved chemicals can be fed to the hot well, to the heater, or to any other place in the system that lends itself to the purpose.

Where an automatic make-up feed regulator is used, the drip valve from the chemical tank should be actuated by the regulator and float in the constant-level feed tank applied under such conditions.

New York, N. Y. J. H. GULLAK.

128. Sight-feed Solution Mixer for Water Treatment.

As in Fig. 39 a reducing coupling is screwed on to the feed-water supply to hot well or feed-water tank. Any convenient-sized chemical bottle, with bottom cut out, is placed in the coupling upside down and packed with asbestos. The feed-water supply is placed about 1 in. into the bottle and to one side. An ordinary drip-feed lubricator of convenient size is placed in the

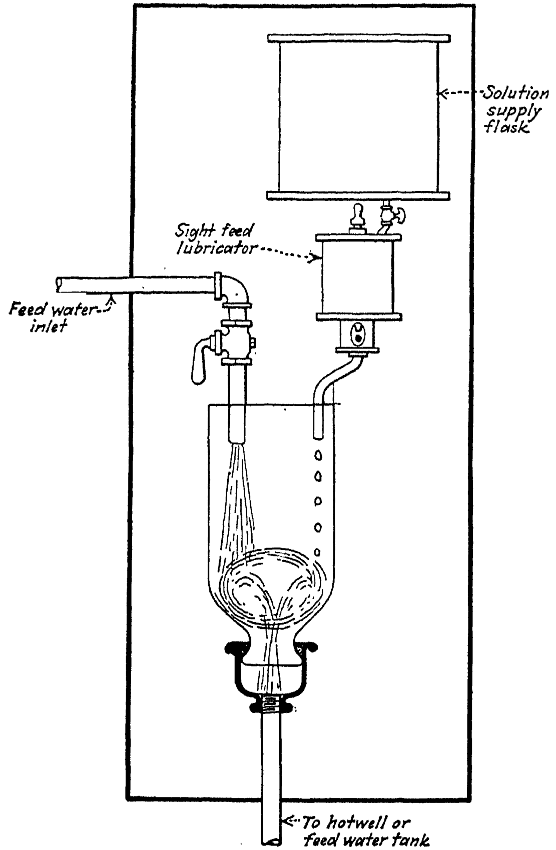


FIG. 39.—Arrangement of visible-solution mixer.

opposite side in the same manner. A supply flask or tank to hold a week's or month's supply, as required, is connected to the drip-feed lubricator inlet as shown.

Feed water makes a whirlpool effect in the neck of the bottle, thereby making a natural mixer to the drops falling from the drip-feed lubricator. Also, this arrangement gives a sight feed-water gage, perfect sight mixer, and a sight-feed solution observer.

Montevideo, Uruguay. E. Kerr.

129. Lubricator as Compound Feeder.

For maximum results, feeding of compound should be continuous and proportional to water evaporated. Many engineers have trouble with homemade feed devices and insist that the firemen use care in adjusting the feed valve, but usually a day's supply is fed in an hour or less.

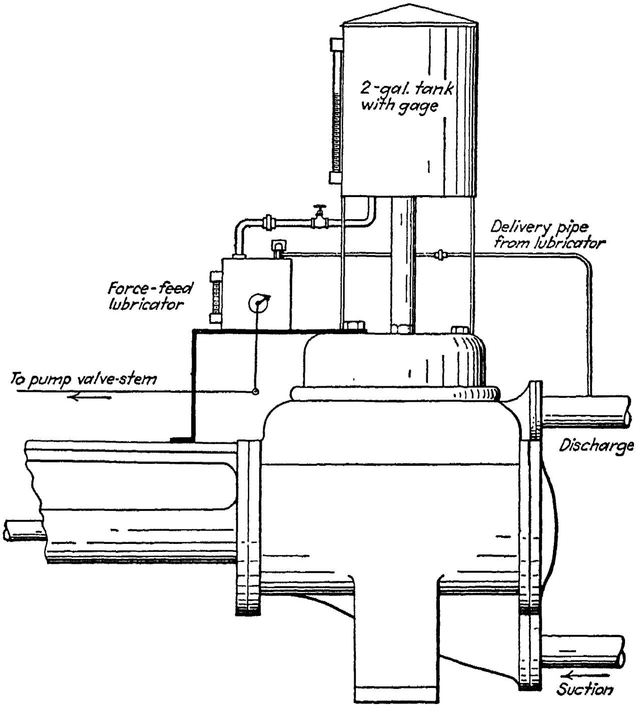


Fig. 40.—Lubricator gives continuous compound feed.

This feeding arrangement (Fig. 40) gives good results. Compound is fed according to the speed of the boiler feed pump, which is governed by the steam demand on the boiler. It is easy to determine the amount of compound needed per gallon of water and to regulate feed accordingly.

Arlington, Mass. E. MacDermod.

130. Complete System for Feeding Boiler Compound.

Figure 41 shows a system used in a power plant containing six boilers. It is somewhat expensive to install for the purpose but gives good results.

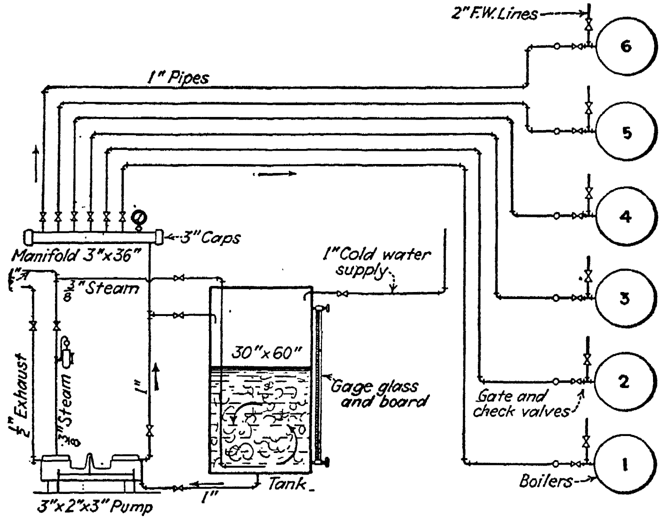


Fig. 41.—Boiler-compound system for six boilers.

This system consists of a 30- by 60-in. tank with gage glass graduated in inches. A 3- by 2- by 3-in. duplex pump, a 3- by 36-in. manifold made of 3-in. pipe, capped at each end (1-in. nipples welded on), and necessary pipe, valves, fittings, etc.

A sample of water is taken from each boiler every 24 hr. and analyzed to determine the amount of compound needed in each boiler.

Powdered compound is used. When the amount needed for each boiler has been determined from the analysis of the water, it is weighed out. For instance, if boiler 1 requires 7 lb.; boiler 2, 10 lb.; etc.—say a total for the six boilers of 45 lb.—45 in. of water is let into the tank. The water is warmed and agitated with steam from the ⅜-in. line, running down in the tank to near the bottom and directed to give the water a whirling motion. Compound is then poured into the water, and when thoroughly dissolved, the required number of inches corresponding to the number of pounds is pumped into each boiler.

When the tank has been emptied of compound, it is filled about half full of fresh water and warmed with the steam, and enough is pumped through each line to flush all compound out.

Memphis, Tenn. B. E. Smithers.

131. Boiler Compound Feeder.

The simple arrangement in Fig. 42 permits delivery of the required amount of fluid into the boiler without contact with pump and in as small quantities or drops as desired. Diameter and length of receptacle *R* should be made to suit the quantity of fluid to be introduced daily, and the degree of opening of gate valves *B* and B_1 will determine the amount passed through hourly. To replenish compound in receptacle *R*, gate valve *A* is opened full, gate valves *B* and B_1 are shut, and drain cock *D* is opened until all liquid empties. Then the vent cock is opened, plug *C* removed, drain cock *D* is shut, and the compound solution poured in until it shows at the vent. Then the vent is shut, the plug screwed in, and valves *B* and B_1 cracked to the degree of opening required.

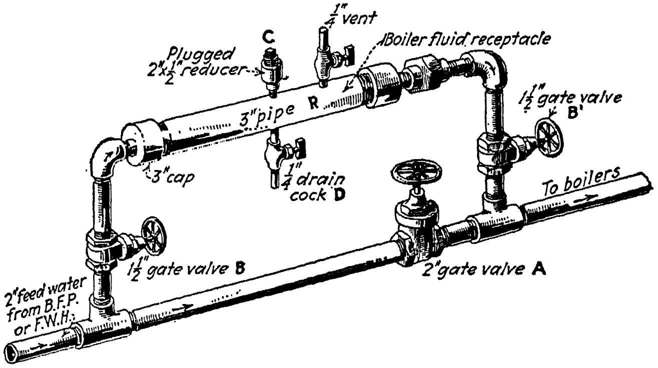


Fig. 42.—Compound feeder connected in feed line.

Toronto, Ont. L. W. Ross.

132. Hydrostatic-regulator Control for Feed-water System.

There are many practical applications of the conventional hydrostatic damper regulator in the boiler room. Figure 43 shows an interesting plan in a high-pressure plant. Feed water was supplied to the boilers by a motor-driven centrifugal pump. A steam-turbine driven pump was also installed for stand-by and emergency. With the small water-storage capacity of modern, high-pressure boilers it is imperative that, at full load, interruption of feed-water flow be for not more than a fraction of a minute. It is also important with high-temperature, high-pressure feed-water piping that, should there be a loss of pressure, the pressure be built up again slowly to prevent water hammer.

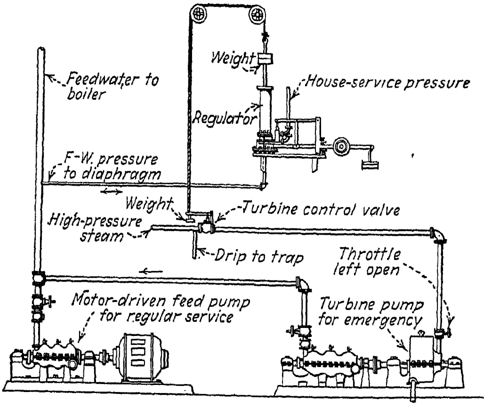


FIG. 43.—Hydrostatic regulator control for feed pump.

The diagram shows piping details for the hydraulic regulator. If the feed pump trips off for any cause, a pressure drop in the feed-water header causes the hydraulic regulator to function and brings the turbine-driven pump up to speed. This regulator is adjusted to prevent more than a 25 per cent drop in pressure in the feed-water header. Weights on the regulator are carefully adjusted to prevent any hunting action.

Cleveland, Ohio. C. O. PERKINS.

133. High-pressure Feeder for Boiler Compound.

In a 1,450-lb. steam plant, older methods of feeding compound to boiler feed water were ruled out. However, it was desirable not to use a special pump unless necessary. The method shown in Fig. 44 was tried, with successful results.

Steel stock 8 by 51 in. was bored with a 5-in. hole to within 1½ in. of one end. The open end was faced off square, and a steel headplate made. A hole was drilled and tapped in the center of the plate for ¾-in. pipe. The cylinder was also drilled and tapped near the top and bottom for ½-in. pipe and then turned down to 7-in. outside diameter to within 3 in. of the top, as shown in Fig. 1. Eight ¾-in. holes were drilled in the head and cylinder, the latter being tapped. The space between the bolt holes on the face of the metal was serrated on both the cylinder head and inside the plate head for a gasket surface.

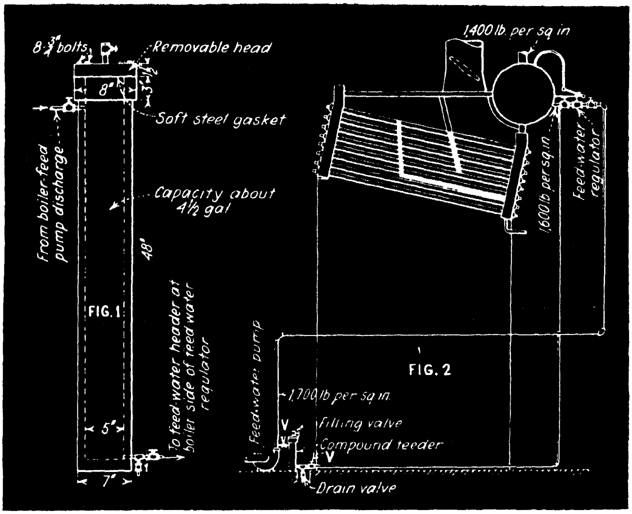


Fig. 44.—High-pressure boiler-compound feeder.

A factor of safety exceeding 5 in all parts was used, assuming a pressure of 1,700 lb. per square inch. A soft-steel gasket in the cylinder head gives best results.

As in Fig. 2, the top of the cylinder is connected to the feed-pump discharge. The lower connection is piped to the feed-water line at the boiler inside the feed-water regulator. Under normal operation, feed-pump discharge pressure is about 1,700 lb., and at the inlet to the boiler about 1,600 lb., the feed-water regulator causing a pressure differential to assure flow in the compound line. Pipe fittings in the ½-in. line were kept to a minimum, bends being used in their stead wherever possible to reduce friction drop.

Compound for 6 or 8 hr. of operation is dissolved in about 3.5 gal. of hot water. The two valves *V* on the cylinder are closed, and the plug in the top filling valve is removed. This valve and the drain valve are opened, and the cylinder drained, after which the drain valve is closed, and the cylinder filled through a funnel placed in the top connection. The filling valve is closed, the plug replaced, valves *V* opened, and the compound will then flow to the boiler.

Waterville, Maine. HARRY M. SPRING, JR.

134. Determination of Total Alkalinity Aids Feed-water Treatment.

The most important use of the knowledge of the salts making up the total alkalinity in boiler feed water is in maintaining proper alkalinity—sulphate ratio—to inhibit caustic embrittlement. Present practice dictates maintenance of a minimum ratio depending on boiler pressure. Since this value is the ratio of total alkalinity, expressed as sodium carbonate, to sodium sulphate, a knowledge of the quantities of various carbonates, bicarbonates, and hydrates is essential to convert them into terms of sodium carbonate.

In actual practice, it is usually customary to express carbonate, CO_3; bicarbonate, HCO_3; and hydrate, OH, as calcium carbonate, $CaCO_3$; together with the calcium, Ca; and magnesium, Mg, ions; also as $CaCO_3$, by means of the following conversion factors:

CO_3 p.p.m. $\times$ 1.667 = carbonate alkalinity expressed as $CaCO_3$ p.p.m.

HCO_3 p.p.m. $\times$ 0.819 = bicarbonate alkalinity expressed as $CaCO_3$ p.p.m.

OH p.p.m. $\times$ 2.941 = hydroxyl alkalinity expressed as $CaCO_3$ p.p.m.

Ca p.p.m. $\times$ 2.497 = calcium hardness expressed as $CaCO_3$ p.p.m.

Mg p.p.m. $\times$ 4.115 = magnesium hardness expressed as $CaCO_3$ p.p.m.

Total alkalinity expressed as $CaCO_3 \times 1.06$ = alkalinity ex-expressed as Na_2CO_3 p.p.m.

Sulphate ion, SO_4, $\times 1.479$ = sodium sulphate, Na_2SO_4, p.p.m.

In addition, a knowledge of the total alkalinity of boiler water will indicate to the plant engineer whether his water treatment is removing all the scale-forming salts, just what scale may be expected, and the concentration of soluble salts in the boiler feed, an excess of which is conducive to foaming and priming.

In the case of raw water, this information is especially valuable in determining the quantities of chemicals necessary to render the water harmless and to prescribe treatment and processes. To the feed-water expert, this knowledge will indicate many other important and interesting facts; but to the plant engineer with a probable limited chemical training, such information is best used as outlined above.

Jackson, Mich. S. E. Tray.

135-139. Five Pointers on the Two Methods of Deaerating Feed Water.

135. The older method of deaerating water is by means of the condenser only. In some point of the plant cycle, a surge tank is introduced to take up the differences that will exist, under various conditions of plant load, between the quantity of feed water required in the boiler and the quantity of condensate being removed from the condenser. This surge tank is sometimes placed immediately after the condensate pump and merely floats on the line. Means are often taken to prevent aeration of water, such as by introducing vapor in the upper portion of the tank, as the water is commonly below 212°F. However, in some plants, surge tanks are connected just before the boiler-feed pump suction, in which condensate temperature runs slightly above 212°F.; the surge tanks can then be vented to atmosphere or a vent condenser.

136. A more recent method of deaerating boiler feed-water is to add a deaerating open heater, besides providing for deaerating in the condenser. This heater is fed with bled steam from the main turbine, and the temperature of the condensate is raised sufficiently to cause it to flash in the heater, thus relieving itself of dissolved oxygen. Occasionally this heater receives exhaust steam from steam-operated station auxiliaries.

137. When no deaerator is used, an additional closed heater is required to make the cycles comparable, inasmuch as the deaerating heater is almost always fed from a turbine bleed point.

138. Comparing two equivalent systems, such as shown in (Fig. 45), one using a deaerator and the other deaerating only in the condenser, the combined deaerating heater and its overflow tank would have a capacity equal to the surge tanks required in the system without the deaerator. In addition, precautions would have to be taken to preclude the aeration of water in the surge tank.

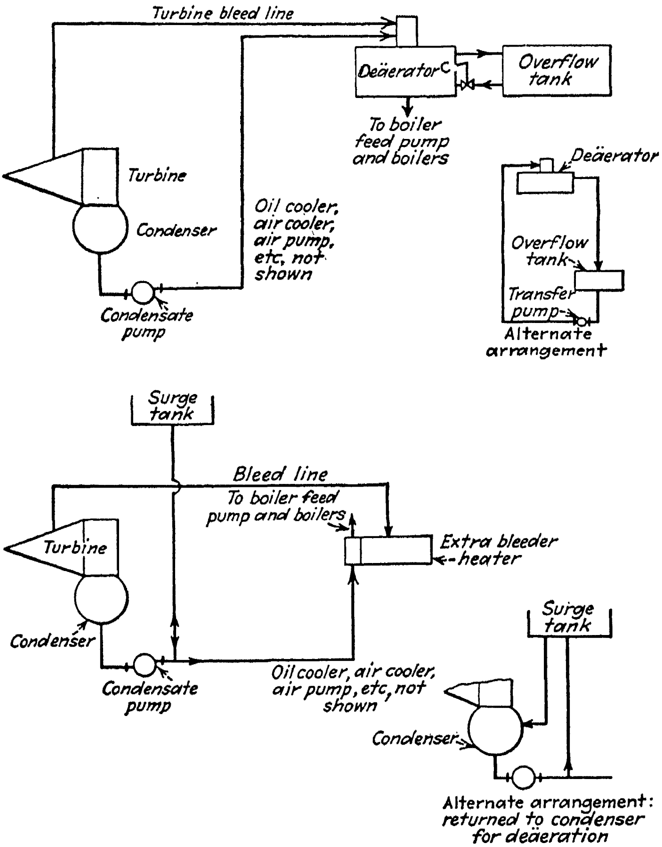

Turbine bleed line
Deäerator
C
Overflow tank
To boiler feed pump and boilers
Turbine
Condenser
Oil cooler, air cooler, air pump, etc., not shown
Condensate pump
Deäerator
Overflow tank
Transfer pump
Alternate arrangement
Surge tank
Bleed line
To boiler feed pump and boilers
Turbine
Extra bleeder heater
Condenser
Condensate pump
Oil cooler, air cooler, air pump, etc., not shown
Surge tank
Condenser
Alternate arrangement: returned to condenser for deäeration

FIG. 45.—Diagrammatic sketch of two deaerating systems, upper with condenser only, lower with condenser and heater.

139. For a typical installation of about 200,000 lb. per hour capacity, costs would be approximately as follows:

Costs	With deaerator	No deaerator, closed heater
Price, f.o.b.	$14,600	$ 4,000
Freight and handling	1,400	700
Erection	2,000	600
Foundation	1,000	600
Total	$19,000	$ 5,900
	Overflow tank	Surge tanks
Price, f.o.b	$ 3,000	$11,000
Freight and handling	300	1,000
Erection	600	2,000
Foundation	600	1,500
Total	$ 4,500	$15,500
Piping		
Condensate		
Bleed	$ 1,500	$ 1,200
Overflow	1,500	1,500
Surge tank	....	2,000
Heater drain and vent (no pump)	....	500
Total	$ 3,000	$ 5,200
Total specific	$26,500	$26,600
Engineering, etc	5,300	5,300
Grand total	$31,800	$31,900

From the foregoing, it is evident that either no saving or little saving would be effected by omitting a deaerating heater.

New York, N. Y. E. H. Krieg.

140. Why Water-softener Capacity Dropped Off.

We have a zeolite 3-in. vertical single-unit water softener. Capacity was 3,900 gal. of soft water per regeneration, based on city water with a hardness of 20 gr. per U. S. gallon. After two years, capacity of the softener dropped to about 3,500 gal. We found that the city had brought in a new well about the time capacity dropped. A sample of the city water was tested by the makers of the softener. They recommended cutting capacity to 3,300 gal. per regeneration, as the city water showed more grains of hardness per gallon. After operating another two years without trouble, we found the same drop in capacity as before. This was not due to a change in the water, as the wells had not been changed.

The cover of the mineral tank was removed, and in one place about 1 ft. wide and extending from the center of the tank to one side we found a spot of rust. We started the backwash and found that the water did not come up through this part of the bed. The mineral was packed very hard in this spot. The bed was stirred up with a rod until water flowed up through. When the backwash water was shut off, we found that this rust was scattered all over the top of the bed instead of on one spot as before. The height of the mineral was found to be about 3 in. too low in the tank. This would account for the dirt's not being removed when backwashing.

In the first batch, after stirring up the mineral bed, the softener ran out 3,300 gal. and showed over ½ in. of lather on the water at the end of the run, using 5 drops of soap solution in 40 cc. of water.

The mineral bed does not need much care besides regular backwash and charging with salt solution. About once a year, it is a good plan to open the top and stir the mineral up, being careful not to stir so deep as to mix the gravel with the zeolite. The only thing to do when they become mixed is to remove the materials and separate them, which is not a pleasant job.

Walthill, Neb. W. W. DINGWALL.

141. Leaky Gage Cocks Avoided When Using Soda in the Boiler.

We found that use of soda was desirable to maintain certain conditions in the water in our boilers. With the use of the soda, however, we noticed that leakage of gage cocks was more common, for before we began using soda we had had no difficulty in keeping them tight.

It was the custom for the fireman to blow down the water column and then try the gage cocks at the beginning of each watch. As soda in the water was the cause of the leakage, the gage cocks were tried first, when there was only distilled water in the water column, and afterward the water column was blown down. This remedied the trouble.

Boston, Mass. M. W. Eastman.

142. Boiler-tube Failures Reduced by Extending Feed-water Header.

In one plant operating 400-lb. water-tube boilers, the last boiler taking water from the feed-water header gave trouble by tube failures. This boiler was the same size and was operated under the same conditions as the others but was the only one to give trouble. Solids entrained in the water were carried through the feedwater header to the last boiler taking water from it. This was probably because impurities are slightly heavier than the water and will not change direction of flow so quickly.

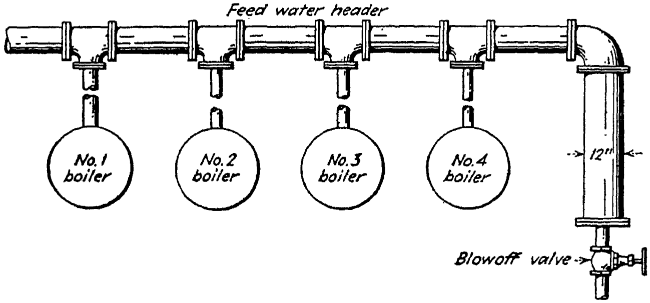


Fig. 46.—Extended feed-water header cuts tube failures.

By continuing the header into a piece of 12-in. pipe mounted vertically (Fig. 46), this trouble was remedied. A blowoff valve was installed at the base of the pipe, which may be from 5 to 20 ft. long depending on the available headroom. By sampling the water in the vertical line at intervals, the proper frequency of blowdown was readily determined.

Milford, N. J. Harry M. Spring.

143-146. Four Helps in Zeolite Softening.

143. The bottoms of our wells tend to fill up with fines and rust. When a well becomes stopped in this way, we use a chisel-shaped tool attached to the end of a length of pipe and work it up and down on the accumulation. Water under pressure is forced from holes in the end of the tool while it is being worked up and down. This loosens the accumulation, which is pumped out. It generally takes from two to four days per well to do this work.

144. Although each well is disconnected from the main before cleaning, considerable air is drawn into the main while it is being disconnected and reconnected. Once large bubbles of air found their way into the header and into the softeners while they were being backwashed. These air bubbles blew the gravel bed against the sides of the tank, letting the zeolite down on the strainer system.

We built a staging alongside of the tank, then used a scoop to remove all that we could reach. We used a long-handled shovel to pull a great deal of it into a position where it could be reached with the scoop. The zeolite was simply thrown into a pile on the floor. After removing as much zeolite as we could without gravel mixed with it, we took pails and removed the remaining gravel and zeolite.

When the tank was empty, we gave it a thorough cleaning. We also inspected the strainer system for loose strainers, but none was found. The gravel was then screened, first through ¼-in. mesh to remove the large gravel, then through fly screening to separate the fine gravel from the zeolite. When screening was completed, the coarse gravel was placed in the tank, followed by the fine gravel and the zeolite.

The softener was then closed up, thoroughly backwashed, and a triple charge of salt run into it and allowed to remain all night. In the morning this was rinsed, and the softener put back on the line.

145. Here is how we washed the zeolite from the gravel: We made two screens 4 ft. long by 2 ft. wide (Fig. 47). One was covered with ¼-in. mesh only and was used to separate the coarse gravel, while the other was covered with ¼-in. mesh screening and fly screening, the ¼-in. mesh being to relieve the fly screen from weight. The screens were placed on top of a barrel in which were bored three holes on a horizontal axis about the middle of the barrel. An improvised nozzle was attached to the end of a hose, and water was directed on to the screen. One man threw the gravel on the screen, and one shook and unloaded it. The coarse screen was used first, and the water washed the fine gravel and zeolite into the barrel, the water overflowing through the holes in the side. When the mixture reached the level of the holes, the barrel was dumped. After the coarse was all recovered, it was placed in the tank, and the fine screen used to separate the zeolite from the remaining gravel. It required about 8 hours to screen 20 cu. ft.

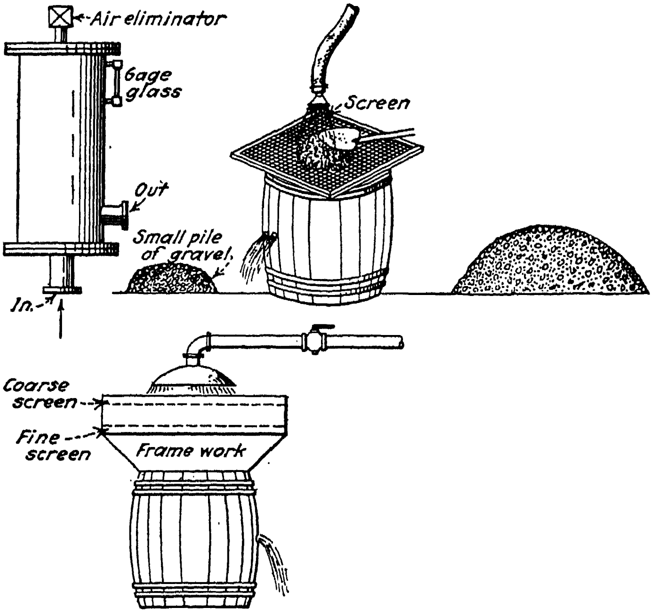


FIG. 47.—Equipment for separating zeolite from gravel.

146. If we had the job to do over again, we would pipe up a spray and build a framework to hold two screens, as shown in the lower view. As a precaution, we are installing an air eliminator to guard against any recurrence of the above trouble.

Watertown, Mass. T. A. WALSH.

147. Preventing Hard-water Leakage into Boiler Feed Water.

Softened feed water was stored in a suction reservoir near the boiler-feed pumps. The engineer relied on the operators to open the valve on an emergency raw-water line to this reservoir in case of interruption in soft-water supply.

We decided to devise a more positive method of maintaining feed-water supply. An external pressure chamber containing a float was connected to the feed-water tank and to a lever-type valve in the emergency water line, as shown in full lines in the diagram.

Several months after addition of the float-valve control, periodic tests indicated that boilers were getting hard feed water. The float-operated valve showed a slight leakage, allowing hard water to mix with the regular soft feed water. To protect the system against this, a check valve was connected in the hard-water line between the float valve and reservoir, as shown by the dotted lines (Fig. 48). The line in which the swing check was connected was changed to a 45-deg. angle by addition of two 45-deg. elbows.

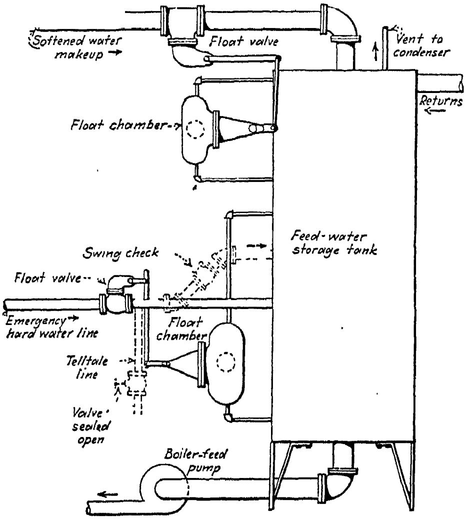


FIG. 48.—Check valve and other changes prevent hard-water leakage.

A weight was brazed on to the under side of the swinging valve inside the check. This caused it to remain seated tightly under its own weight in case of a low tank head on its pressure side; but when the float valve opened, the check would lift easily. A $\frac{3}{8}$-in. telltale line was tapped into the bottom of the emergency line between the check and the float-operated valve. A globe valve was connected in this line and sealed open. If the float valve leaked, it was indicated by a drip from the telltale line. In case of an interruption in the supply of softened water, the lead seal was broken after the float valve was opened, and the telltale valve closed.

Atlanta, Ga. W. R. MOORE.

148. Scale in Feed-water Pipe Caused Error in Meter Reading.

In a plant where the feed-water meter was the only means of obtaining a check on the amount of steam used by the turbines, it was discovered that steam consumption had been gradually increasing for some time. The turbines were overhauled, switchboard meters checked, and other expedients tried in an effort to locate the cause of the apparent increase in steam used. Finally, it was decided to take down the section of feed-water pipe in which the pitot tube for the meter was connected. Inside this pipe, which was 4 in. in diameter, was found a layer of scale about ⅛ in. thick. As the thickness of this scale increased, water velocity also increased and caused the meter to give a higher reading than normal.

After the pipe was cleaned, steam consumption of the turbines was again normal.

Westfield, N. J. GORDON R. HAHN.

149. Why the Softener Did Not Work.

In our paper-mill plant, we operate a base-exchange softener for treating the make-up water. We have a closed system of return on the paper machines, but the steam used in the sulphite mill is, of course, lost and has to be made up.

The softeners had been in operation for about a month and giving satisfactory service. The soap test showed good results. Then, one day, we could not get a satisfactory test.

The first things that occurred to us were that the mineral bed had become channeled or disturbed or that we were not registering correctly. The system was checked up and found correct. Then we discovered that the softener was not functioning at all. We took out the filter bed and prepared to examine the interior. At this stage, we tried the pressure to see how the sprinklers were working. When we turned on the water, the source of the trouble became apparent.

At the top of the filter tank, a cast-iron fitting was screwed on to a close nipple. This fitting was so designed that inlet water went in at one side and, continuing down, was carried by a piece of pipe to the under side of the sprinkler plate. After leaving the bed, the softened water passed out of the other side of the fitting. The casting was broken at the raw-water connection, and, instead of going through the mineral, the raw water short-circuited and went out of the soft-water connection.

Port Arthur, Ont. R. G. EDWARDS.

150. Condensation Reservoir Improves Reducing-valve Operation.

Plant conditions required a pressure of 2 lb. in the steam space of a deaerating heater to insure proper deaeration. Owing to deficiency in the exhaust steam available for use in the heater, a reducing valve was installed to supply the additional steam from a higher pressure source. It was necessary because of

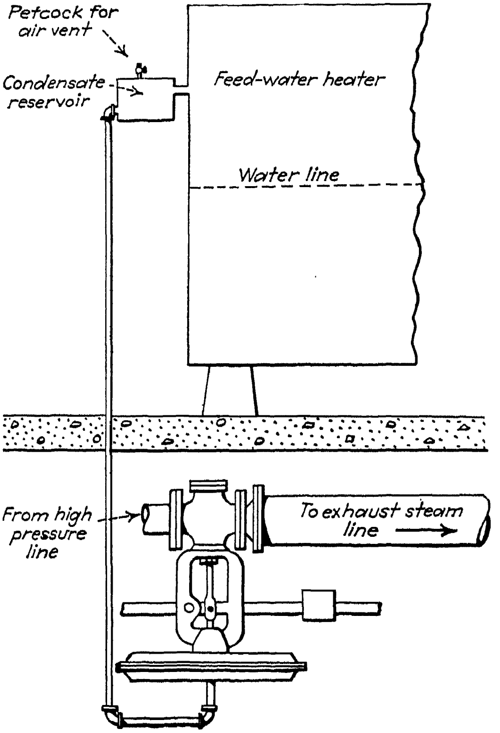


FIG. 49.—Condensation reservoir betters reducing valve operation

piping arrangements to install this valve in the basement below the floor on which the heater is.

Fluctuations of pressure were encountered which seriously interfered with proper functioning of the equipment. The trouble was a variation of the static head of water in the small vertical pressure line between the heater steam space and the reducing valve diaphragm, caused by the pumping action of the diaphragm as the reducing valve opened and closed to meet sudden load fluctuations. This trouble was eliminated by installing a condensation reservoir made up of a 4-in. diameter pipe nipple and eccentric fittings in the pressure line adjacent to the heater, as in Fig. 49. The water storage in this reservoir is sufficient to compensate for the variation in the water content of the diaphragm chamber, insures a constant static head, and eliminates practically all trouble from pressure fluctuations.

Waynesboro, Va. S. H. COLEMAN.

151-153. Three Methods for Cleaning Oil Coolers.

151. Oil coolers must be kept clean of scale and sludge. Composition of the scale on the water side of tubes will depend on impurities in the water. Much of the scale can be removed by boiler-scaling tools, but the scale in inaccessible places is best removed by a weak hydrochloric acid solution. As the acid solution is passed through the cooler, it will dissolve the scale and will turn the solution a milky white. As soon as the solution begins to come out cleaner, this treatment should be stopped so that the metal parts are not attacked. The cooler should then be flushed out with water at high velocity, hot if possible. This will remove acid solution that may remain in the cooler and will also remove any loose particles of scale.

152. Another way of removing scale that is less drastic than acid treatment is to make a solution in the proportions of 1 lb. of common soda to 1 gal. of water. Water space of the cooler should be filled with this solution as hot as possible. Steam connections should be made, and live steam admitted to the cooler so that the solution is kept boiling. This treatment is continued for 3 hr., when the solution is drained out, and the cooler flushed with water. A great deal of scale will be washed out, as the soda water will have softened and loosened it. If washed out with water at a high velocity, most of the scale will be removed.

153. Sludge on the oil side can be removed by a solution made by dissolving ½ lb. of caustic potash per gallon of water used. Bring this solution to the boiling point and fill the oil space with it. Steam should be admitted to the lower part of the cooler, so that the solution is kept boiling to assist any dirt and sludge to rise to the top and overflow. This treatment should be continued until no more impurities are rising to the top. The solution should then be drained off, and the cooler well flushed out with water.

Hertfordshire, England. W. E. WARNER.

154-156. Three Hints on Separating Oil from Feed Water in an Open Heater.

154. Most engineers have in their own plants the means of making an effective oil separator. There are few plants without an open feed-water heater. This type of heater can be used to separate oil from water, particularly from oil that has emulsified.

We put a substantial bed of coke in the heater. Coke has an affinity for oil and readily absorbs it. This is simple and cheap, as coke can be picked out of the ash heap to fill the heater.

155. With a closed heater, conditions are different. In that case, an improvised coke-oil extractor can be placed in the suction line to the feed pump. Containers for the coke can be made from oil drums or sections of large-diameter pipe.

156. For a while we used charcoal in our heater as an extracting medium, but after experimenting with coke we found it worked equally well, is cheaper, more readily obtainable, and can be changed as often as necessary.

Rosedale, L. I. JOSEPH O'BRIEN.

157. Venting Drain-pipe Seal.

Pressure of exhaust steam sent through a closed feed-water heater being quite low, the engineer decided to dispense with the steam trap for discharging water of condensation and allow the water to drip directly into the sewer. This was done to avoid clogging of the trap by an oily deposit from the condensate, due to the lack of an effective oil separator in the exhaust line. To insure that no steam should blow through the drain pipe, the engineer devised a sealing arrangement of four vertical lengths of pipe connected together with return bends, as shown in Fig. 50.

Since exhaust pressure rarely exceeded 2 lb., he figured that making the seal 4 ft. high would give a sufficient head of water to hold back the steam.

But the drain did not work. Drainage water rose almost to the height of the exhaust outlet before the engineer discovered that something was wrong. He concluded that air trapped in pockets somewhere in the seal was the cause of the difficulty. Drilling and tapping the upper return bends to receive the small vent pipes, indicated by the dotted lines in the sketch, removed the trouble.

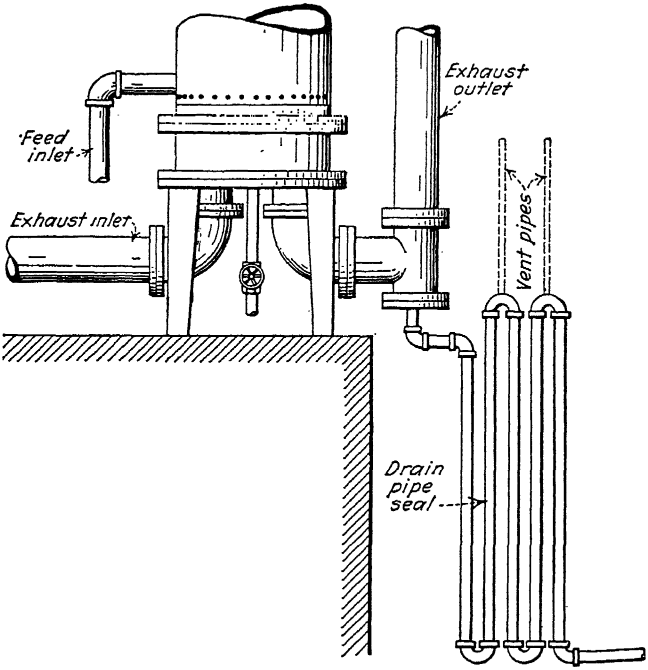


Fig. 50.—Air vents necessary to drain pipe seal.

St. Louis, Mo. A. J. Dixon.

158. Check Valve as Vacuum Breaker.

It is frequently necessary to provide some sort of vacuum breaker on a closed tank used for the storage of water, for example, an auxiliary feed-water storage tank. A check valve, connected to a threaded opening in the top of the tank with a pipe nipple and so placed as to open into the tank, serves the purpose effectively and at little expense. Either a vertical- or angle-type check should be used.

Arlington, Mass. THERON W. BEAN.

159. Leak Stopped in Blowoff Tank.

The blowoff tank was in the boiler-room basement. After ten or twelve years it began to leak, and examination showed that a large patch on the bottom directly beneath inlet *A* (Fig. 51) was necessary. Apparently, erosion was caused by the cutting action of the stream of water, for it was not observed elsewhere. Water was about 4 ft. deep, thickness of bottom plate $\frac{5}{8}$ in., and steam pressure 195 lb.

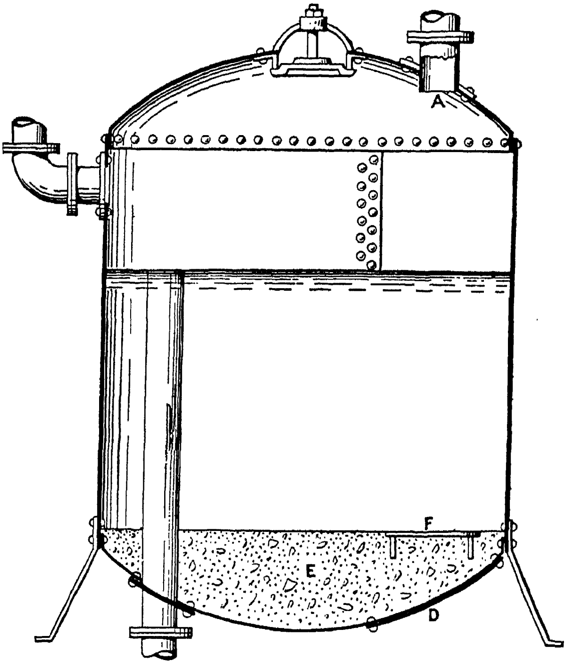


FIG. 51.—Method of repairing blowoff tank.

Patch *D* was put on the bottom plate, and about 12 in. of concrete placed in the bottom of the tank. In addition, an old blank flange *F* with several short nipples screwed into it was laid in the concrete opposite the inlet *A*, the top of the flange being even with the top of the concrete. These repairs were made many years ago, and the tank has not leaked since.

Elgin, Ill. W. L. PARKER.

160. Operation of Open Heater Improved.

When this open feed-water heater was first put into operation, the temperature of feed water never went over 195°F., with exhaust steam escaping through the back-pressure valve. The recording gage on the exhaust line showed that back-pressure varied from 4 to 7 lb., with little variation in load on machines exhausting into the line.

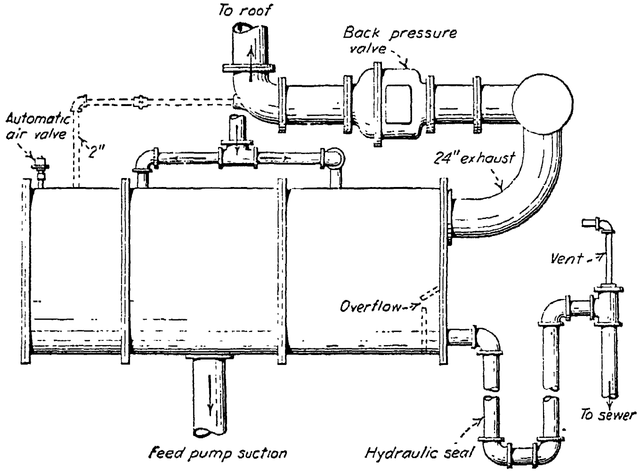


FIG. 52.—General arrangement of heater and connections.

The exhaust steam enters the heater at one end through a 24-in. line (Fig. 52). There are three ¾-in. automatic air valves at the other end, to take care of air entering the heater with the steam. A 2-in. pipe was connected, as shown by the dotted lines, from the top of the heater to the exhaust pipe going to the roof, and immediately the temperature of the feed water rose to 214°, and back pressure dropped to 3 lb., with no steam going to waste at the exhaust head.

Variations in back pressure were caused by undersized air valves, allowing the heater to get air bound until the pressure built up enough to force the air out. Then as the steam passed through the heater it condensed, and back pressure dropped.

New York, N. Y. THOMAS SHEEHAN.

161. Heater Make-up Valve Used as Feed-pump Regulator.

We had trouble in keeping normal water level and were losing large amounts of hot water because the heater overflowed into the sewer.

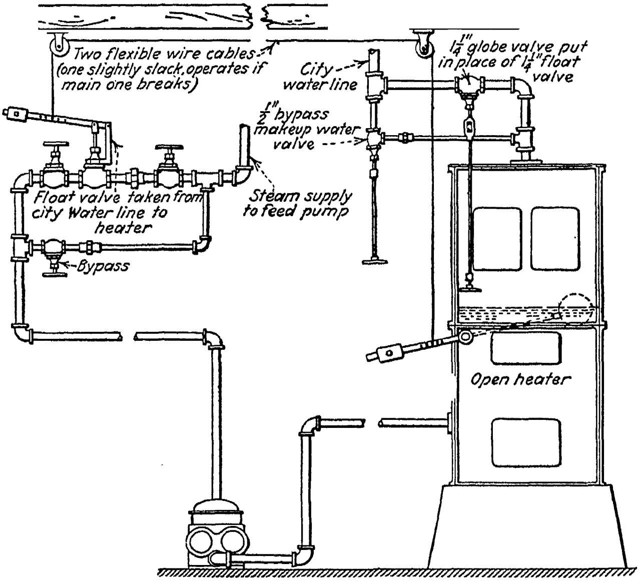

Two flexible wire cables (one slightly slack, operates if main one breaks)
City water line
$1\frac{1}{4}''$ globe valve put in place of $1\frac{1}{4}''$ float valve
$\frac{1}{2}''$ bypass makeup water valve
Float valve taken from city Water line to heater
Steam supply to feed pump
Bypass
Open heater

FIG. 53.—Connections to heater and feed-pump control.

Load was fairly steady, and all returns were trapped and returned to the heater. The feed pump was manually controlled; that is, whenever the fireman noticed it, he would try to speed up or slow down the pump as the boiler required. But such control caused trouble. Here is how we fixed it:

The float-operated valve was taken out of the city water line and replaced by an ordinary globe valve, which was shut and meant for emergency use only. The float valve was put in the steam-supply line to the feed pump and was arranged to operate from the float in the heater by means of a cable, as shown in Fig. 53. When boiler water level was being maintained a little lower than half a glass, the make-up valve was cracked open, and extra feed allowed to enter the heater slowly; in this way, no effect is noticed on the boiler pressure due to cold water entering the heater.

Feed water now enters the boiler at between 190 and 210°F., and no more hot water finds its way to the sewer.

Union City, N. J. RUDOLPH BOETTINGER.

162. Safety Valves on Water Heaters.

A coffee urn was heated by copper coils, which received the steam from the boilers used in heating a hotel, pressure to the coils being reduced by a pressure-reducing valve.

The urn was not provided with a safety or relief valve. A hole developed in the coils, permitting the steam to escape into the urn. As a result, a pressure was built up which blew the vessel up, causing approximately $500 damage, besides scalding two waitresses.

Had the urn been equipped with a relief or safety valve, this accident would not have occurred.

Binghamton, N. Y. CHARLES W. CARTER, JR.,
State Boiler Inspector.

163. Discarded Boiler Used as Receiver for Steam Trap Discharge.

All tubes were removed from an old h.r.t. boiler, and the holes in the heads plugged with small sheet-metal disks brazed in the holes with an acetylene torch. The object of removing the tubes was to increase the capacity of the tank. The hood formerly supporting the smokestack was also detached.

A circular hole 6 in. in diameter was then cut in the center of the rear head, and a short flanged nipple bolted on to serve as the vent connection. Beside this hole and near one edge of the head, five holes were drilled and threaded for 1-in. pipeline connections.

A concrete base was then built outside the boiler room, and the old boiler placed on it upright, with the end containing the pipe nipples upward. The 6-in. pipe extended upward some distance above the roof and served as a vent to carry off the vapor arising from the hot water discharged into it by the traps.

There were five traps in use at this plant, and a 1-in. diameter pipe line is connected to the discharge of each. These five pipe lines extend along the surface of the earth to the base of the reservoir, where they turn upward and connect at the top through return bends. A 3-in. diameter pipe line connected with the original water cock in the side of the old boiler is connected with the injectors of boilers now in service.

Cairo, Ga. L. M. Jordan.

164. Old Boiler Made into Feed-water Heater.

Tubes were removed from an old h.r.t. boiler and an extra steel plate riveted over the tube-hole section of the original heads. The boiler was then mounted on timber saddles and connected through a 2-in. pipe line with an elevated water tank and a small pump. The discharge side of the pump connected with a coil inside the old boiler made from 300 ft. of 2-in. pipe. Exhaust steam from steam-operated equipment is connected to one end of the old boiler, and the steam passes over the coils and gives up heat to the water, the excess steam passing to the atmosphere through a back-pressure valve set to release at 3 lb. The pump draws water from the reservoir and forces it through the coil in the heater to the plant boilers.

Cairo, Ga. L. M. Jordan.

165. Steam Heater for Exposed Water Tanks.

Some years ago, we were bothered with a tank's freezing up; so we bent a length of ½-in. pipe into the water tank and connected it with the steam supply. A check valve was connected into the line between the regular valve and tank to prevent a vacuum from forming in the pipe after the steam was closed off and drawing water into the pipe. A small opening of the steam valve kept the water from freezing.

Ladysmith, B. C. W. A. Cooil.

166. Preventing Pitting of Closed Heaters.

Portland cement should be mixed half and half with fine, clean, sharp sand to the consistency of paint and stirred frequently while being used. As soon as it has hardened sufficiently, mix a fresh batch and apply second and third coats over the first one. Should the heater have means of ventilation, this coating will be hard enough to put the heater into service in 8 or 10 hr. It may be that from time to time some small pieces will scale off, but this can be easily repaired.

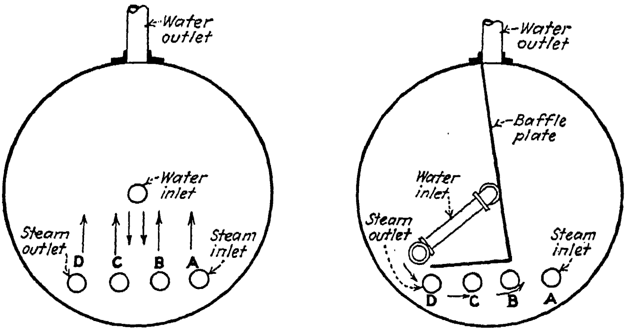
I have protected the interior of several steel tanks used for feed-water storage, and of considerable size, that were found badly corroded. After cleaning and scaling the interiors and applying several coats of cement wash mixed as above, no further corrosion was noted.

All tanks aboard steamships for carrying fresh water are protected from internal corrosion by cement. This also applies to feed-water storage tanks.

Troy, N. Y. J. F. Nagle.

167. Changes Improve Water-heater Operation.

Changes here described produced an increase of 15°F. in the outgoing water temperature and an increase of about 20 per cent in the capacity of our hot-water tank heater and are applicable to any tank where the steam coil is made up of straight pipe and return bends.



Old Arrangement New Arrangement

Fig. 54.—Section through water-heating tank, with old and new arrangements.

As shown in Fig. 54, water entered the tank at the center of one head and flowed by gravity to the bottom, meeting some resistance from the upward movement of hot water rising from the steam coil. This arrangement also had the effect of giving a lower temperature at the water outlet than existed at the point where the water left the steam-coil surface, as the hot water from the end of the coil nearest the tank-head inlet had to pass through a blanket of cold water in order to reach the outlet.

Another defect of the old arrangement was that with a coil of four longitudinal pipes, steam inlet at *A*, and drip at *D*, all condensation found in *A*, *B*, and *C* had to pass through pipe *D*, thus greatly reducing the heat transmission of that part of the coil due to the water film.

The first change made was a new method of introducing cold water into the tank. The cold-water pipe, which came flush with the inside surface of the head, was extended by means of nipples, elbows, and pipe so that cold water was sprayed directly against pipe *D* for approximately its entire length. This arrangement, due to creating an increase in the temperature difference, made pipe *D* as effective as the others and was mainly responsible for the increase in capacity. Hot water rising from the remainder of the coil is no longer blanketed by incoming cold water; thus the increase in outgoing water temperature is realized.

It was then decided to place the baffle as shown, in order to provide a positive circulation of water and thus insure that the water would sweep against the entire surface of the steam coil. It was found possible to operate with a reduced steam pressure on the coil, as the water was then heated to within a few degrees of the steam temperature. Formerly at peak load, the high steam pressure used on the coil gave such a high condensate temperature leaving the coil that considerable vapor was lost by flashing. The new arrangement gave at all times a condensate temperature below 212°F.

Further experimenting proved to us that the amount of hot water used by tenants in the building decreased in proportion to the increased outlet temperature. This is due to the fact that for lavatory or bath use, increased temperature forces the use of cold water for dilution and eliminates to a great extent the practice of allowing water from the hot-water tap to run to waste a few seconds each time a faucet is opened, in order to get hotter water.

Springfield, Mass. A. F. SHEEHAN.

168. Control for Feed-water Temperature.

A closed feed-water heater was piped to the boiler feed pump as shown in Fig. 55. It was found after installation that on peak loads a higher temperature rise through the heater was obtained than expected. At times, the temperature of feed water at the suction of the feed pump was so high for the available suction head as to cause partial steam binding of the pump. The location of the heater and the pump could not be changed to give a greater suction head without considerable expense, and as this trouble did not occur frequently, some other arrangement for its prevention was desired. A control which automatically bypassed the heater enough to hold the suction temperature at its maximum possible operating temperature at such times was installed as shown.

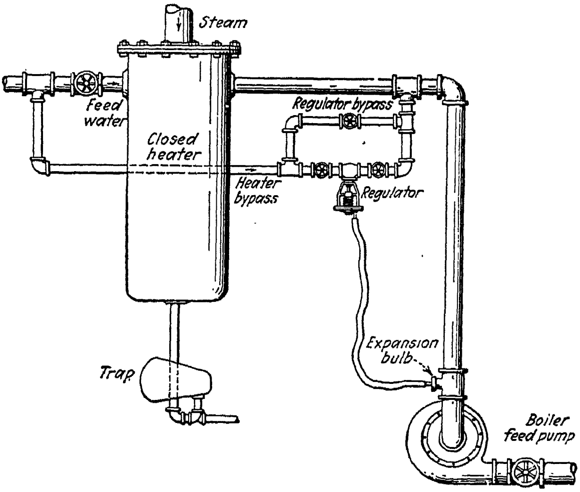


FIG. 55.—Arrangement of heater and by-pass.

Milford, N. J. H. M. SPRING.

169. Improvement.

I should like to know why Mr. Spring heats part of the feed water to the point of converting it to steam, only to cool it later by adding cold water. Certainly temperature can be reduced by adding cold water, but why overheat in the first place? Would it not be simpler, and certainly more economical, to control the heat flowing to the heater? All that is necessary is a throttle or regulating valve in the steam-supply line to the closed heater. This valve may work automatically, with the temperature of the feed water from the heater controlling it in the same manner as Mr. Spring controls his by-pass regulator.

The advantages of regulating the heat supplied to the closed heater over the by-pass method of regulating feed-water temperature are lower first cost and lower radiation losses. The initial installation will be simpler, requiring three less valves and probably six less fittings. Radiation losses will be less owing to the lower operating temperature of the closed heater.

Media, Pa. W. S. Hobbs.

170. Failure on Boiler-feed Line.

In February, 1923, the equipment in our heating plant was put in service. The plant then consisted of four 6,120-sq. ft. water-tube boilers operating at 225 lb. gage with stokers burning No. 3 buckwheat coal. Boiler-feed lines are cast iron, designed for a working pressure of 250 lb. tested to 425 lb. Feed-water pumps are turbine-driven, 3-stage centrifugals, and each boiler is fitted with a feed-water regulator.

There had never been any trouble with the feed line. One evening in 1930, after load was cut and only two boilers were in service, operating at about 125 per cent rating, the 5-in. cast-iron feed line back of boiler 2 developed a crack.

The section of pipe affected was found to be well filled with blowholes between the inner and outer surfaces and to be of unequal section.

The break caused temporary shutdown of the plant until the boiler feed could be shifted to the auxiliary line. Had the break occurred when the four boilers were operating at 200 per cent rating, it might have caused serious damage to some of the boilers.

Ithaca, N. Y. C. E. Curtis.

171. Electric Alarm Systems for Feed-water Heater Level.

In one station, the feed-water heater is at the top of the boiler room, and to see the water level in the gage glass attached to the heater it is necessary for operators to climb about 55 ft. At certain times, difficulty is experienced in maintaining sufficient water supply; also in event of high water, there is danger of water from the heater's flowing into the exhaust line to the boiler feed pumps; so it is necessary at all times to know the water level in the heater. An alarm system is indispensable.

The system is essentially a water column so arranged that floats establish an electrical contact with wires leading to a panel on the control platform through spark plugs. Three short lengths of 4-in. pipe connected by couplings form the main body of the column and give greater accessibility to the floats, spark plugs, guides, etc. The column is connected top and bottom by 1-in. pipe with a gate valve in each connection. A blowoff line, with a valve in a convenient position, is brought down from the bottom of the column.

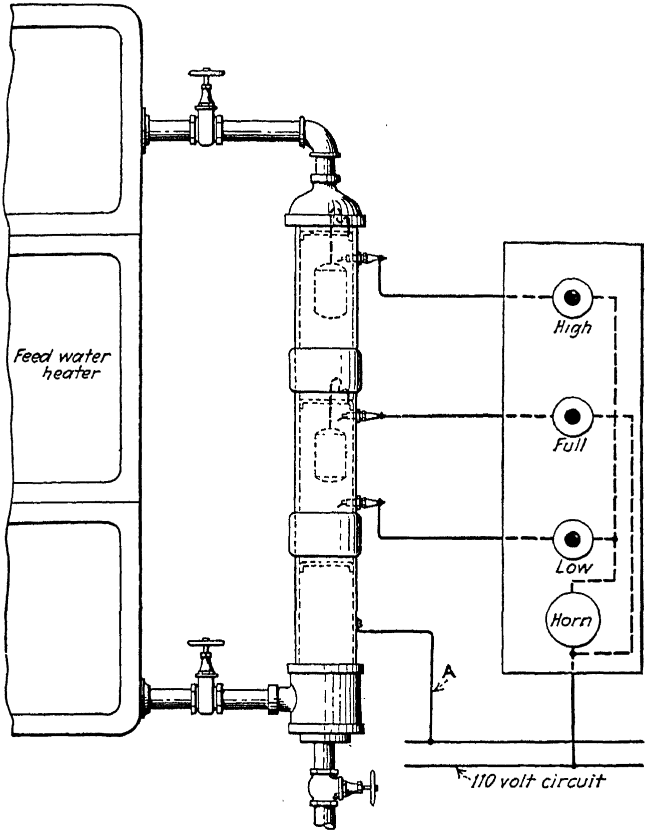


Fig. 56.—Level-indicating panel is placed in view of operator.

In the float chamber, three guides of sheet iron extend horizontally across the pipe, as shown in Fig. 56, and serve to hold the floats in their respective positions. The spark plugs are in the side of the column at the point where the high-, full-, and low-water zones begin. To the tip of the spark plugs are soldered copper strips 1½ by ½ in., to establish a contact between the floats and the spark plugs sufficient to carry a current strong enough to light the lamps and blow the horn on the control panel. Lights on the panel are arranged to reflect through the words "high," "full," and "low" outlined in stained glass. The horn is connected to blow for high and low water.

Directly attached to the top of each of the floats is a wire that extends upward and over to a point on the upper guides. The float chamber is connected electrically by means of wire *A*, and, inasmuch as the upper guides are directly attached to the float chamber, the floats serve to complete the circuit between the column and the spark plugs.

Greensboro, N. C. W. B. BURKE.

172. Combination Manual and Automatic Feed-water Regulation.

In a power plant supplying a textile mill, water level would jump from 4 in. to a full glass when the steam engines suddenly picked up a load of approximately 1,000 hp. The reverse would happen when load was dropped.

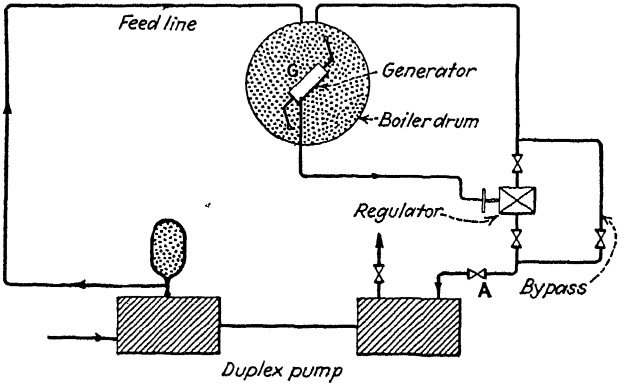


FIG. 57.—Feed-water system arranged for manual and automatic control.

Setting the feed-water regulator generator was a problem. If set to carry the water level at one-half gage glass, the boilers would prime when starting the engines. If the water was at that level just before shutting down, when engines were stopped, water would disappear from the glass because of circulation in the four-drum, water-tube boilers.

To insure safe operation, water level had to be down to 4 in. in the gage glass when starting and at ¾ glass when the engines were stopped. To accomplish this, boiler feed pumps were manually controlled during starting and stopping, and automatic control was used during normal operation.

Now, generator *G* is set to carry the water level at ¾ glass (Fig. 57). When starting, steam to the feed pump is throttled by closing valve *A* to ⅛ turn open 5 min. before the whistle blows, which slows the pump down to give 4 in. of water in the gage glass.

Five minutes after the starting whistle blows, valve *A* is opened to ¼ turn and allowed to remain that way during normal operation of the plant. Under this condition, the automatic regulator maintains the water level in the boiler at ½ glass.

At 5 min. before the stopping whistle, valve *A* is opened to ¾ turn, which causes water level in the boiler to rise to ¾ glass. This takes care of the sudden drop in water level when the engines are shut down. Valve *A* is left ¾ turn open until water level has returned to a ¾ glass, all load off, when the boilers are ready for blowing down.

The boiler operators have, of course, had to be schooled into this routine, but the change in operation has relieved their trouble considerably.

Toronto, Ont. LESLIE W. ROSS.

173. Remedying Troublesome Feed-water Heater.

The discharge pipe from a vacuum pump attached to a heating system was connected to an open feed-water heater directly opposite the orifice through which the exhaust steam entered, as in Fig. 58. The heater would not raise the temperature of the feed water to the degree which the quantity of entering exhaust steam seemed to warrant. Disturbing noises also occurred in the vacuum pump's discharge pipe, and occasionally a severe water hammer would jar the horizontal section from end to end. Temperature of condensate passing through the discharge line was over 100°F. at all times, often as high as 150°.

Entering the heater at the top, the supply water rained down from a series of pans set one below the other, while steam passed upward through the thin sheets of falling water. The engineer thought that the trouble might be cured by introducing the discharge from the vacuum pump into the top of the heater. So he changed the piping as indicated by the dotted lines, arranging a pocket in the piping into which he tapped the supply of make-up water. Altering connections in this manner stopped water hammer and gave a higher feed-water temperature.

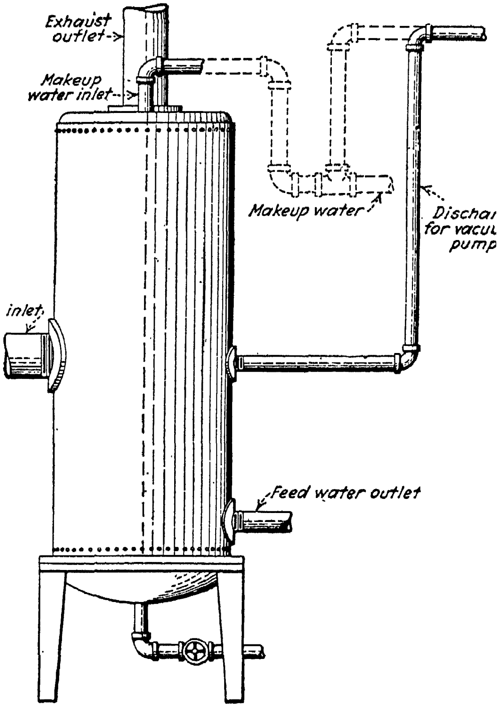


FIG. 58.—Rearranged piping eliminates water hammer.

St. Louis, Mo. A. J. DIXON.

174. Seal Pipe on Heater Solves Overflow Difficulty.

An open-type feed-water heater was furnished with an overflow device consisting of a balanced valve actuated by a float incased in an external chamber set at the maximum allowable water level in the heater. This device was in communication with the heater through a vertical pipe running down to a connection at about the heater's mid-height, also through an equalizing pipe extending from the float chamber to the top of the heater. A float inside the heater actuated a regulating valve in the water-supply pipe. Exhaust steam was supplied at a pressure of about 8 lb., which kept feed water at close to 235°F.

Occasionally friction in the joints and stuffing box would temporarily prevent movement of the float mechanism, thus causing trouble.

To avoid this, the operator decided to cut a hole in the shell of the heater at the maximum water level and attach a simple overflow pipe with a seal in it, as shown in Fig. 59. He figured that by dropping the loop in the piping to a depth of 22 ft. he would have a column of water sufficient to seal against the 8-lb. steam pressure in the heater.

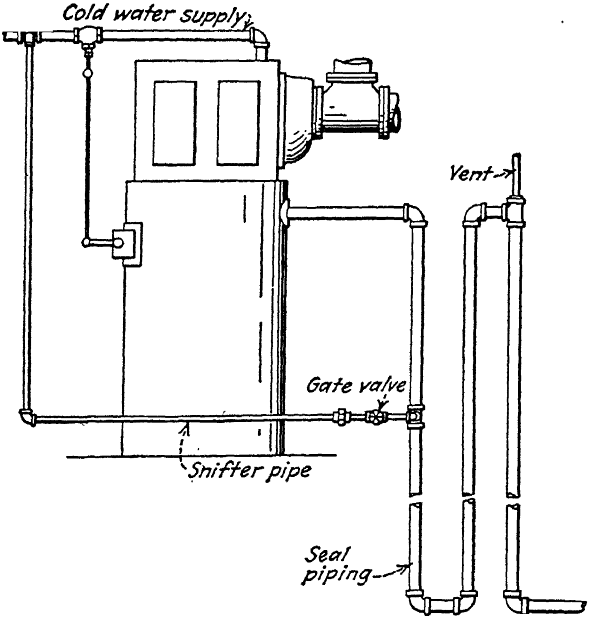


FIG. 59.—Heater with water-sealed overflow pipe.

But when first tried, all the water was blown out, followed by a blast of low-pressure steam, because no provision had been made for giving the descending leg a "snifter" of cold water. After this omission had been supplied, as indicated, the vent worked. (Cold water was needed because of the comparatively high temperature of the heater water.)

But admitting cold water by means of a hand-operated valve just when it was needed called for greater vigilance on the part of the boiler-room crew than could reasonably be expected. So the device was made automatic by installing a thermostatically controlled valve in place of an ordinary gate valve, the thermostat being attached near the lower end of the descending leg.

St. Louis, Mo. D. J. ALLISON.

175. Automatic Control Valve for Make-up Boiler Feed-water.

A diaphragm plate *P* (Fig. 60) is made from a piece of ½-in. steel plate, hollowed on one side to permit free circulation of the pressure water for controlling the make-up-water valve. On the under side of *P*, rubber diaphragm *R* is attached. It rests on a disk on the top end of the make-up-water valve stem. When make-up water is not required, pressure water from the city main is admitted above the diaphragm to hold the make-up-water valve closed. When returns to the feed-water heater are insufficient, pressure is released from above the diaphragm, pressure of the make-up water under the valve opens it, and water flows to the heater.

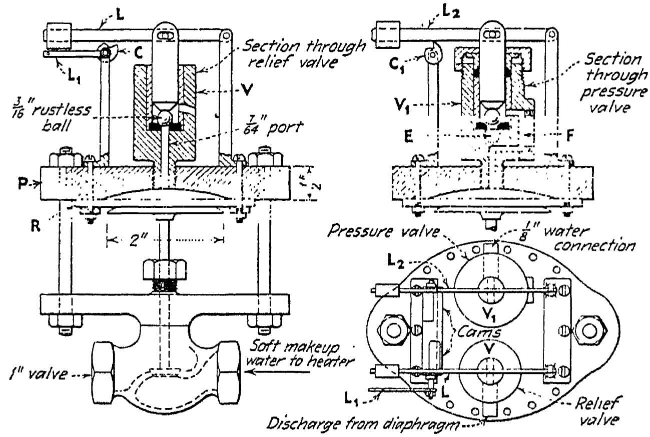


FIG. 60.—Automatic-control valve for make-up.

Control of the make-up-water valve consists of two ball-type valves. Functioning of these valves is regulated by the height of the water in the feed-water heater by a float. One valve relieves the pressure on the diaphragm and is shown in section at *V*. The ball is held on its seat by a weighted lever *L* and is allowed to raise off its seat by the cam *C* lifting lever *L*. Cam *C* is rotated by the movement of the float in the feed-water heater connected to lever L_1. The other valve, shown in section at V_1, controls the pressure on the diaphragm through a ball valve, the valve being held to its seat by the weighted lever L_2. This lever is also lifted by a cam C_1 controlled by the same float as the cam C. In fact, the two cams are on the same shaft as shown by the diagram in the lower right-hand corner of the illustration. Pressure water is admitted under the ball valve through connection E, from the city main. When the weight of the lever is lifted off the ball, water flows through port F into the diaphragm chamber to hold the make-up-water valve closed.

Positions of the cams C and C_1 in the figure are those when the returns are sufficient to maintain the water level in the heater at a correct level. Under this condition, weighted lever L rests on its ball valve and holds the discharge port from the diaphragm chamber closed. Cam C_1 has lifted weighted lever L_2, and pressure water from the city main passes up through the ball valve and into the diaphragm chamber and deflects the rubber diaphragm downward to hold the make-up valve closed.

Low water in the feed-water heater allows the float to take a position where it will turn the cams to a position to lift lever L off its ball valve and put the weight of lever L_2 on its ball valve. This operation cuts pressure water off from the diaphragm and releases the pressure on the diaphragm through valve V, which allows the pressure of the make-up water under the valve to open it and restore the water level in the feed-water heater, at which time the control is returned to the position shown in the figures, and the make-up valve is closed. It should be understood that the cams are so arranged that pressure control valve V_1 closes slightly before the relief valve V opens, and V closes before V_1 opens.

The valve disk does not lift more than ⅛ in. and is easily taken care of by the rubber diaphragm. Round iron forms the body of the ball-valve unit which has brass plungers and liners. A piece of monel metal was used for the ball seats. Supports for the cams and the weight arm fulcrums were made of ⅛-in. steel.

Edmonton, Alta. F. POLLOCK.

CHAPTER III

BOILERS, SUPERHEATERS, SOOT BLOWERS, AIR PREHEATERS, BLOWDOWN

176. Simple Method of Cooling Bent-tube Boilers with Induced-draft Fans.

This consists of a piece of galvanized-iron pipe and two elbows; one is placed in the lower drum manhole, the other in the nearest door in the setting (Fig. 61). When the pipe is in place, the fire-doors are closed, and the induced-draft fan started. This causes air to be drawn in at the manholes in the upper drums, down through the tubes to the mud drum, and out through the fan to the stack.

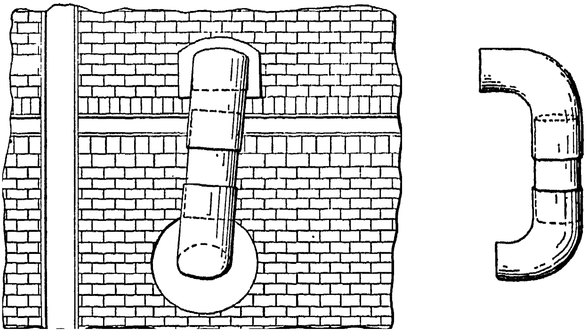


FIG. 61.—Sheet-metal pipe connects mud-drum manhole with nearest door in boiler setting.

We can take a boiler out of service at 12 o'clock midnight and enter it at 8 A.M. the next morning. Of course, after the steam is blown out, the water is changed. A connection of this kind would be harder to install on an h.r.t. boiler, on account of longer connections to the boiler setting, but it could go in the fire door. I know of one case where it gives good results in a plant having natural draft.

Winona, Minn. E. H. KIRCHNER,
Chief Engineer, Mississippi Valley Public Service Co.

177. Volume of Steam from One Gallon of Water.

The question was asked me by one of our water-plant men, "How much steam do you get from a gallon of water?"

He was not satisfied with my answer of "about eight pounds," so I made up the curve (Fig. 62) for my own information as well as future inquisitors.

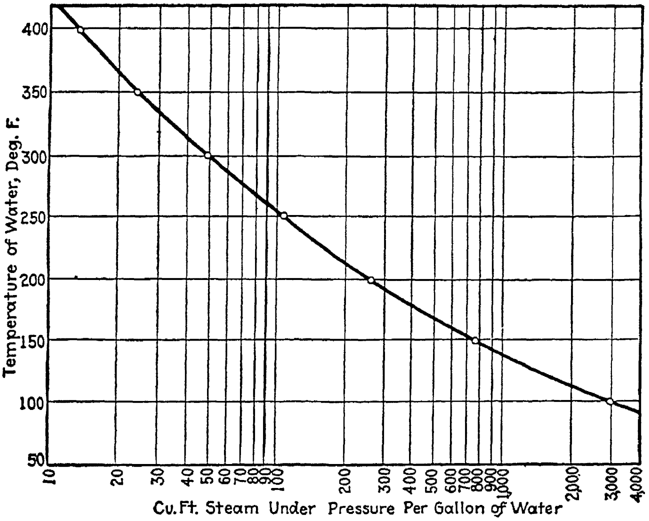


Fig. 62.—Amount of steam from 1 gal. of water at various temperatures.

This curve gives the number of cubic feet of steam, under corresponding pressures, obtained from one gallon of water under given temperatures.

Cleveland, Ohio. C. W. Stevens.

178. The Value of Circulation.

A Lancashire boiler was found with the plates at the lower neck of the furnaces severely corroded and grooved. Grooving was due to faulty circulation, permitting the water to cool down at this point while the boiler was on bank. This trouble would have been largely prevented had circulators been fitted and equal temperature maintained throughout the boiler.

Brentford, England. W. E. Warner.

179. Installs Sediment Tank to Prevent Gage-glass Blowouts.

Good operating routine makes it advisable to blow down boiler gage glasses and water columns about three times or more every 24 hr. This prevents an accumulation of suspended scale, or sludge, which might block steam or water connections. The sudden temperature change accompanying blowdown of a gage glass is responsible for most failures.

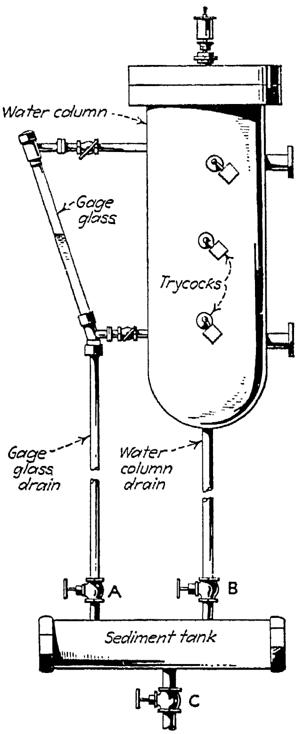


FIG. 63.—Sediment tank to avoid gage-glass blowouts.

At one plant where much trouble was experienced with gage-glass failures, a small sediment tank was installed, as in Fig. 63. Valves *A* and *B* are normally open, while valve *C* is closed. When it is desired to blow down the column and glass, valve *A* is closed, *B* is cracked, and *C* is opened. This blows out any sediment which has entered the water column or glass and settled into the sediment tank. Valve *B* is then closed, and *A* is cracked. This slight circulation will have little effect on the glass temperature, as the principal pressure drop occurs in the tank. After blowdown, the valves are left in normal position, as previously described.

When installing a sediment tank, it must be remembered that this tank operates under boiler pressure. A short length of 3-in. extra-heavy pipe is easily adapted for this purpose, and such a construction is shown in the figure.

Cleveland, Ohio. M. E. WAGNER.

180. Use Steel Bar as Guide When Replacing Boiler Tubes.

Replacing a leaky boiler tube is not an easy job at its best. Repair crews often find considerable difficulty in lining up the new tube with the hole in the baffle wall. With the heavy tubes as used in high-pressure boilers, there is considerable weight to support. Much time is taken in getting the end of the tube started through the first baffle.

This job can be simplified if, after the new tube is pushed through the header about halfway to the first baffle, a steel bar about ¾ in. in diameter and 5 or 6 ft. longer than the tube is passed through inside it. A man inside the furnace can guide the bar through the baffle hole with comparatively little trouble. This bar will support the tube, which can be moved along the bar to the baffle. With the bar as a guide, the job of getting the tube through the baffle will be considerably simplified, time saved, and breaking of brickwork reduced.

Boston, Mass. CHARLES A. ARMSTRONG.

181. Boiler Tube Replaced in Two Sections.

When a tube becomes defective in a horizontal fire-tube boiler and cannot be removed without tearing down a brick wall, the tube may be blanked off or may be replaced in two sections.

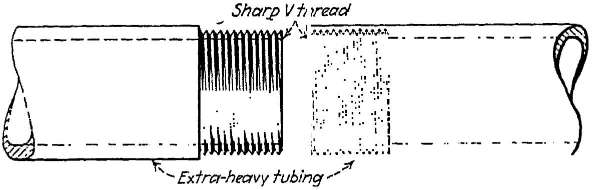


FIG. 64.—Two-section arrangement of extra-heavy boiler tube.

Figure 64 shows an extra-heavy boiler tube cut in half. One end of one section is turned down to half thickness for about 2 in. This machined portion is threaded with a sharp V thread. One end of the other half is bored out to a size equal to the diameter of the thread root in the first half. The recess in the second half is bored back 2 in. and threaded with the same pitch thread as the first half.

The rear half of the boiler tube is pushed through the front-tube sheet until about 1 ft. protrudes. The joint is then tightly screwed up, and the tube pushed through until it is in position. The ends are then expanded and beaded to prevent the sections from separating.

Brookline, Mass. H. M. SPRING.

182. Method of Removing a Boiler Tube.

This crimping tool is made of 1½-in. machine steel, flattened at one end for the jaw and not tempered too hard. If this device is made as shown, it will be found to be one of the most valuable tools in the boiler room when used properly.

Water tubes, as specified, shall project through the headers not less than ¼ in. and not more than ½ in. Extend the crimping tool through the handhole cap on to the edge of the tube, as in Fig. 65, and bend the edge of the tube inward all around. It can then be removed easily without using an oyster knife or ripping chisel.

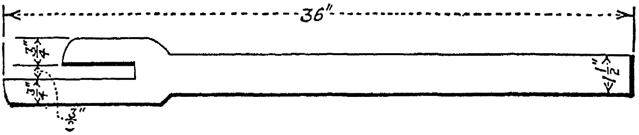


Fig. 65.—Crimping tool for removing boiler tubes.

After a tube is bent inward all around at both ends, it can be easily taken out whole or in part by cutting in pieces with an acetylene torch. If the tube cannot be cut by a torch, it can be started by using a piece of hardwood through the handhole cap and giving a few taps with a sledge hammer.

Holtwood, Pa. M. W. Horley,
Boiler Engineer, Holtwood Power Co.

183. Tube Cutter for Return-tubular Boilers.

In small plants, it frequently happens that when a tube or flue for return-tubular boilers needs replacing, no tube cutter is available. Although the tube can be cut out with a chisel, there is danger of damaging the tube sheet; therefore a suitable tool for cutting the old tube off inside the sheet should be used where possible.

Select a piece of ordinary pipe a size smaller than the tube to be cut, one that will just fit inside the tube. This piece should be long enough to reach out through the firebox, so that a handle through the outer end may be used to turn the pipe.

A stub piece of shafting *C* somewhat smaller than the bore of the pipe is drilled and tapped at one end to receive a stud bolt carrying a knurled pipe-cutter wheel (Fig. 66). Two ⅜-in.

holes are then drilled through the pipe *B* and through the stub shaft *C* for two rivets. The bottom side of the stub shaft should be tapered, and a wedge fitted below it, the function of the wedge being to feed the cutter into the tube.

In operation, the tool is inserted in the tube until the cutter is just inside the boiler sheet. The wedge *F* is then tapped in, forcing the cutter against the inside of the tube. The pipe *B* is turned by means of the handle *G*, and the process continued until the tube is cut through.

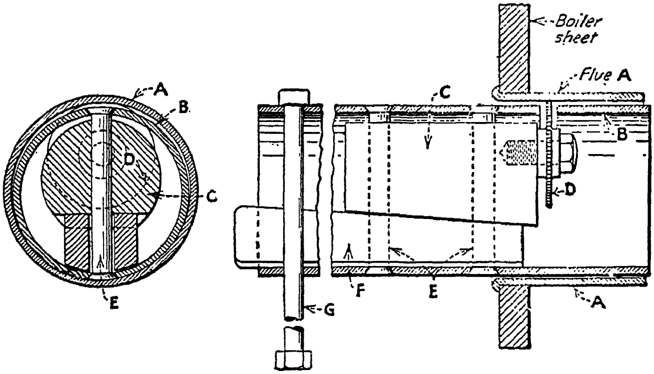


Fig. 66.—Section through boiler tube, showing cutter in position.

North Bend, Neb. G. G. McVicker.

184. Pointers on Boiler Cleaning.

A procedure we have used for cleaning and testing boilers is: For the regular period of cleaning and repairs, we usually test the boiler with cold-water pressure of about 50 per cent of normal working pressure. After extensive repairs or tube replacements, a cold-water pressure of about 90 to 95 per cent of the working pressure is used. This is sufficient to show any leaks. Once a year we make a thorough external inspection, and before doing this we have a reliable man blow out all soot with an air lance and then take a hose with good water pressure and wash down all drums and tubes. If this is done right, it leaves the shells and tubes in a nice clean condition and greatly facilitates inspection.

By doing this once a year, the guess is taken out of the work. The boilers are known to be in good condition, and a good report is assured when the boiler inspector makes his rounds. We have been doing this for more than twenty years and have never experienced any trouble. We have never found a boiler inspector that did not say that this plan was O.K.

Ajo, Ariz. W. Brown.

185-188. Four Tools to Facilitate Boiler Cleaning.

Figure 67 shows some tools we have made to facilitate the washing of our boiler and the cleaning of the ground joints on the headers and caps.

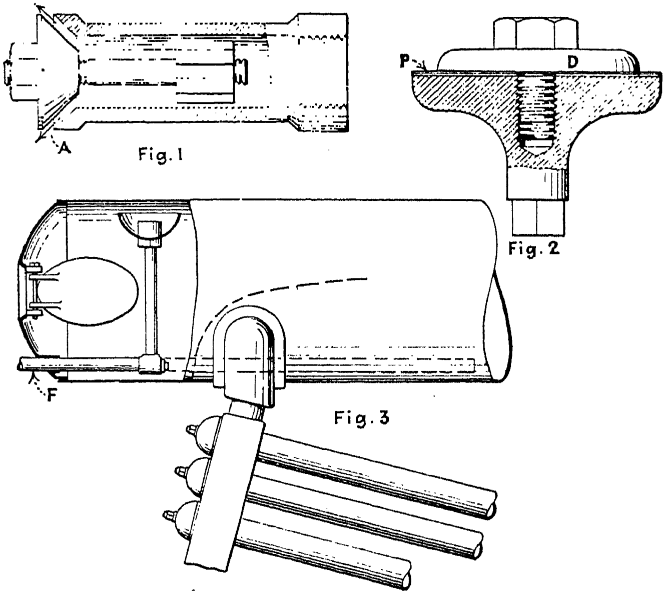


Fig. 67.—Tools for washing tubes and cleaning header and cap joints.

185. Cleaning tool (Fig. 67-2) is made to fit the hand brace and to carry two or three sheets of sandpaper, *P*. Clamping disk *D* enters the cap holes in the headers and serves as a guide. The tool is light and easy to handle. For cleaning the faces of the caps and nuts, we have a machined cast-iron block upon which sheets of sandpaper are clamped.

186. Figure 67-1 shows how we altered a spray head to make it suitable for washing tubes. The end of the head and deflector plate were each given an angle of 45 deg., and the opening was spaced so as to produce a conical discharge of water at high velocities, as at *A*. This spray head, with a pressure of 125 lb. on it, makes a good job of washing the tubes.

187. In boiler drums, the manheads are hinged as shown. We insist on this for convenience and also because it permits us to use the same gasket over and over again.

188. Originally, the boilers were fed through a horizontal pipe extending along the bottom of the drum to a point 5 ft. from the front head. These pipes gave trouble by filling with scale, so they were finally removed, and the water was fed into the steam space as shown. A plugged T with a riser in the side outlet was installed, the T being placed so that the swinging manhead would clear the riser. On the upper end of pipe F, we fitted a spherical tray, as shown, clamping it in place between a lock nut and a T screwed on the side outlet. After a run, the pan and riser were generally found to be heavily coated with mud and scale. We are well pleased with this method of feeding boilers.

Elgin, Ill. W. L. PARKER.

189. Air and Water Drive Boiler-tube Cleaner.

We use what we believe to be one of the best tube cleaners obtainable. We kept cutter wheels sharp and used water for driving at the pressure specified (100 to 125 lb.). The cleaner, however, did not seem to run fast enough to clean the tubes properly. By way of experiment, we connected compressed air to the cleaner, and it then ran fast enough to clean the tubes in a reasonable time. Finally, we connected both air and water to the cleaner. The air gives it the necessary speed to do the work, and the water keeps it cool and washes away the dirt.

Elgin, Ill. W. L. PARKER.

190. Supporting Roll for Boiler-cleaner Hose.

To make the task of running the cleaning tool through the tubes of fire-tube type boilers easier and to save wear on the turbine hose over the edges of the tubes, I have found the roller support illustrated useful and well worth the time of making and applying when cleaning jobs are at hand.

It consists of a roll *A* (Fig. 68) of hard wood with a short shaft in each end made from lag screws with the heads cut off. Roll supports or brackets are made in two pieces and riveted or bolted together and then drilled for the shaft ends.

Details of the expanding plug for holding the device in place on the tube sheet are shown at *B*. A taper plug and a piece of split tubing together with the bolt are used, and pins are put in as shown for holding the split tube against turning.

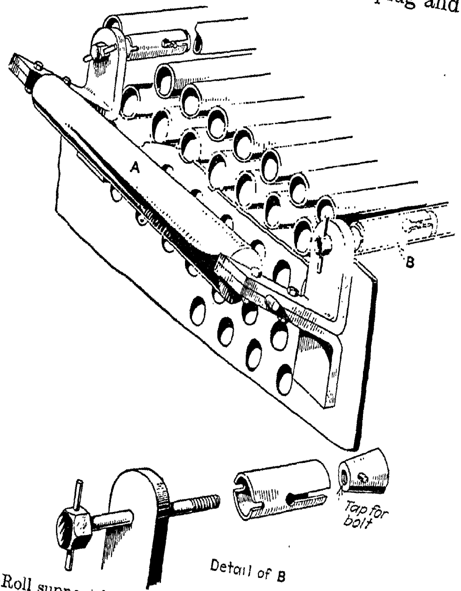


FIG. 68.—Roll support in place and detail of holding attachment.

Concord, N. H. CHARLES H. WILLEY.

191. Furnace Temperature Damages Boiler-supporting Columns. Recently, when inspecting a battery of three horizontal boilers, I noticed that the feed-water line was out of position. When checking up on the boilers, I found that the center boiler was 1.5 in. lower than the outside ones and these had turned in their settings. The boilers were taken out of service, and examination of the settings revealed that the center steel supporting columns were sprung.

These boilers were originally set for hand firing and later equipped with mechanical stokers. The increase in furnace temperature when using the stokers was sufficient to overheat the supporting columns until the weight of the boilers caused them to bend.

The boilers were emptied and lifted to their proper position by hydraulic jacks, then timbered in this location. The jacks and damaged columns were then removed, and new columns installed inside 10-in. tile pipe, as in Fig. 69. To keep the columns cool, the bottom and third-from-bottom sections of the tile pipes were selected with a 4-in. T. From these, 4-in. branches were extended outside the brickwork. When the masonry was put back into place, the tops of the tile pipes were left open so that there was a free circulation of air through them to keep the columns from overheating.

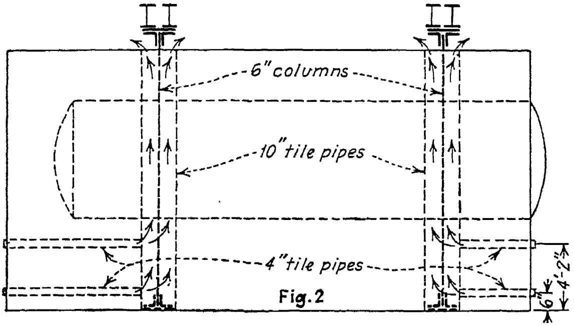


FIG. 69.—Tile pipe and vents keep support columns cool.

Fall River, Mass. B. BOVENZI.

192. Misplaced I Beams in a Boiler Setting.

The use of supporting beams in a center wall between boiler furnaces is poor practice. Where boilers are suspended, the crosspieces should be of sufficient strength to carry the load without support in the center. If for any reason it is deemed advisable to support the span in the center it would appear to be better practice to carry the brickwork up to a height that will support the span without.

Trenton, N. J. G. M. GALVIN.

193. Leveling Boiler Drums.

There should be a slight pitch from the front of the drum to the rear to allow water to drain out to the blowdown. Usually, slight settling is caused by stretching of the U-bolt suspension rod. This rod is secured by a nut at each end at the top, and in some cases the rod is pulled by tightening of these nuts in order to pull the drum back into the correct position. This is a mistake, as an excessive stress will often be set up in the U bolt or threads by this method.

In most boilers of the longitudinal-drum type, a cleanout door is located high on the side wall. Directly opposite this door, several bricks are left out of the inside of the side wall. A heavy timber should be laid across these supports, and a screw jack placed at the middle. The drum can then be jacked into correct position, and the nuts drawn up, and the jack and timber removed. It must be first ascertained, however, that the settling is caused by this trouble and not by the foundation's settling or any buckling from overheating of the main columns.

West Roxbury, Mass. HARRY M. SPRING.

194. Cracks in Return-tubular Boiler Repaired by Welding.

It is quite common for return-tubular boilers, after many years of service, to develop fire cracks in the girth seams. The sheet cracks from the rivet hole to the edge of the plate.

In one boiler, we cut out 12 rivets where there were nine fine cracks. The old metal at the cracks was cut out to about ½ in. wide to get to good stock. When they were rewelded, a piece of carbon from an old dry cell was inserted in the rivet hole to keep the weld from flowing into the hole. The carbon was slightly smaller than the hole but was wedged in to hold it in place. After the weld was made, a long tapered punch was driven into the hole to expand it to full size. It was assumed that this operation would relieve the stresses in the welds which had caused the previous failure. After all cracks were welded and the rivet holes expanded, a portable electric grinder was used to smooth off the plate. One-inch cap screws were then put into the rivet holes, and the nuts drawn as tightly as possible with a 2-ft. wrench. One bolt was taken out at a time, and new rivets driven. To date there is no leak.

Libby, Mont. FRANK E. BATEMAN.

195. Steadying Level in Water-tube Boilers.

Fluctuations in steam demand for various processes in a manufacturing works were both frequent and excessive. Steam was generated in a single water-tube boiler of the horizontal-drum type. The outlet was in the rear shell course of the drum. It opened directly from the steam space, no device intervening to prevent priming or siphoning of the water under heavy drafts of steam. As a consequence, water level was erratic.

So the engineer installed the dry pipe shown in Fig. 70. Fluctuations of water level, as seen in the gage glass, now rarely exceed 2 in. in height. Apparently, the dry pipe gathers the steam for the outlet flow uniformly from end to end of the steam space. There is no localization of a copious liberation of steam from the water directly under the outlet nozzle. Hence there is no priming. Along the upper side of the pipe are two rows of holes through which the steam enters from the top of the drum. The ends being capped, a few small holes were drilled in the bottom of the pipe to provide drainage.

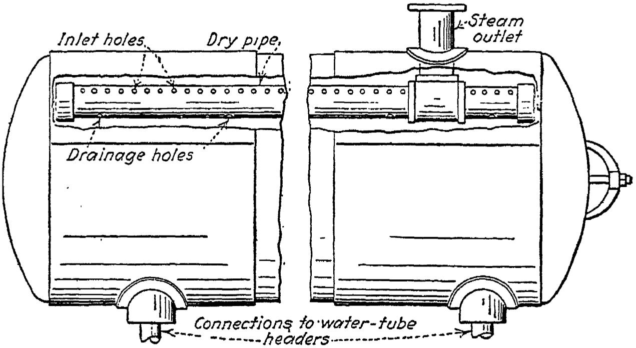


FIG. 70.—Pan suspended under outlet and long dry pipe that prevented priming.

Chicago, Ill. D. J. ALLISON.

196. Improvised Dry Pipe for Return-tubular Boilers.

Two return-tubular boilers that were considerably overloaded gave priming trouble. Main steam-outlet pipes were 4 in. in diameter. Separators were installed on each boiler outlet pipe ahead of the engines, but more than once the separators were flooded, and some water reached the engine cylinders.

By way of experiment, the thread on one end of a 4-in. nipple was cut deeper and screwed into the outlet flange. This helped but was not a cure. Then a 4- by 6-in. bushing was screwed on the nipple. This was followed with a 6-in. flanged coupling with a piece of heavy screen wire between the two flanges, as shown in Fig. 71. This simple device could be put on or taken off in a few minutes and completely eliminated the trouble.

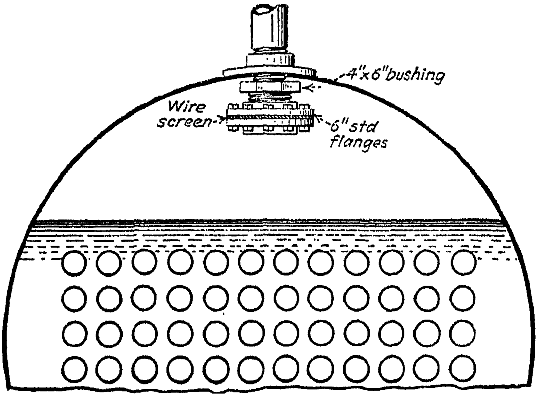


FIG. 71.—Improvised dry pipe attached to steam outlet.

Toronto, Ont. J. E. NOBLE.

197. Circulating Pipe Connection on Scotch-type Boiler.

Figure 72 shows a circulating pipe connection recommended as a cure for the cold bottom common to Scotch boilers.

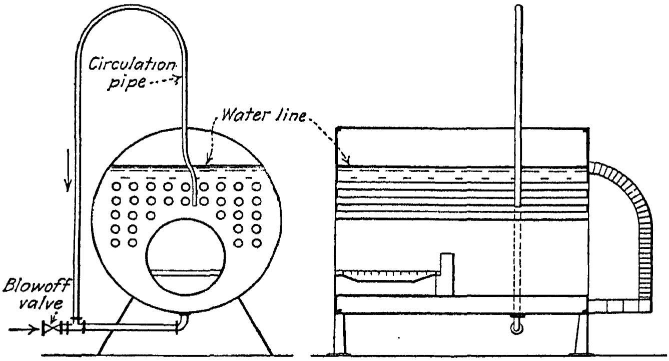


FIG. 72.—Cure for cold bottom common to Scotch boilers.

The circulation pipe is a bare 2-in. pipe connected to the boiler as shown, with the top connection extending well down below the water line and left open, while the outer end is carried about 6 ft. or more above the top of the boiler.

I saw one boiler equipped as shown. While no readings were available to show the difference in temperature between the steam and the bottom of the boiler, which carried about 100 lb. gage pressure, to the hand no difference could be distinguished. Perhaps the scheme combines the principle of the Holly loop and the coffee percolator.

Brooklyn, N. Y. IRA A. BUTCHER.

198-200. Three Hints on Failure of Fusible Plugs.

The failure of fusible plugs other than by melting, due to lack of water, is often brought about by the failure of the plug from corrosion, this usually taking place on the fire side. Normally, the flue gases should not be corrosive at this point owing to lack of moisture, but a slight water leak past the plug will render them active and highly corrosive.

198. In one instance, a fusible plug failed after eighteen months, the thread being severed from the bottom of the base.

The plug was heavily scaled on the water side, but the surface underneath was found to be uncorroded, while on the flue side the plug was deeply corroded, and a deposit of coppery hue was present. On analysis, this deposit was found to consist of 12.6 per cent copper carbonate, 44.1 per cent copper sulphate, 20.1 per cent zinc sulphate, and some further solid matter from the feed water, this having a slight acid reaction. A crack was found which permitted water leakage; this had rendered the flue gases corrosive, which, together with solids from the feed water, had caused corrosion and failure.

199. In another instance, a fusible plug failed, the corrosion being confined to the screw threads; this was thought to be due to the alkaline reaction of the boiler water and to electrolytic action, owing to the gun metal plug's being in contact with the steel furnace crown.

A white deposit was also found which, on analysis, proved to be white lead. No white lead had been used in making the joint, only a graphite compound.

As the gun-metal plug contained a high percentage of lead, and the water contained sodium carbonate which would attack the metal of the plug, the corrosion would form insoluble white lead, which would account for the white lead formed. A slight water leak had probably occurred due to corrosion or a badly fitting plug.

200. Should a plug be thought to leak, however slightly, it should be removed and examined at the earliest opportunity; otherwise the threads may be eaten away. The fusible core should be removed for examination at each annual inspection, and the entire plug each alternate year. The metal of the plug should be suitable to withstand the action of the feed water, and feed water with a highly alkaline reaction should be avoided on account of its possible action on the plug.

Brentford, England. W. E. Warner.

201. Troublesome Blowoff System Corrected.

This steam-making plant consisted, originally, of three h.r.t. boilers. Three more boilers of the same type were installed, and a fuel economizer added. Figure 73 shows a plan of the complete installation, the two groups of boilers being set back to back, with an intervening space in which the blow-off pipes were laid. The 2-in. blowoff pipes running out from the boilers were connected to two 4-in. mains which merged through a branch fitting in a single main pipe. This pipe ran out to a blowoff tank sunk in the ground about 50 ft. from the boiler house. The blowoff pipe leading from the economizer was joined to one of the branch mains.

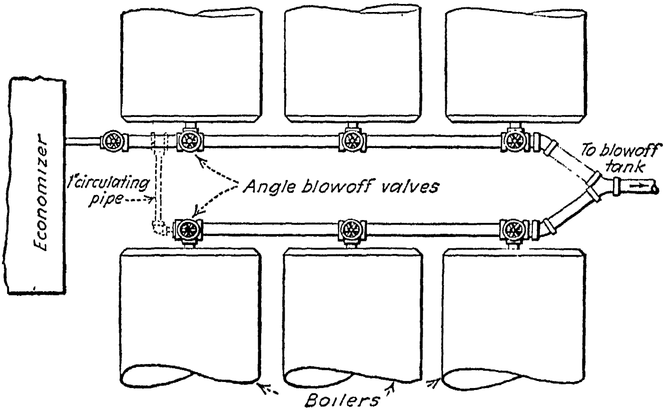


Fig. 73.—Circulating pipe cross-connecting blowoff mains relieves water hammer.

At first, the arrangement did not work satisfactorily. When one set of boilers was being blown down, a severe water hammer would occur in the main branch to which the other set was connected. The difficulty was remedied by running a 1-in. connecting pipe between the inner ends of the branch mains, as shown by the dotted lines.

St. Louis, Mo. A. J. DIXON.

202. Portable Staging for Vertical Fire-tube Boiler Furnace.

Figure 74 shows a staging easily constructed from two pieces of lightest-weight channel iron and a wood block. These channels are about 6 in. longer than the internal furnace diameter and are about 12 by 3 by ¼ in. The sides of one channel are cut off at each end with a hack saw or torch to at least 9 in. from the end. Bottom sections are then heated with a torch and bent to bring them on a level with the bottom of the top channel. The channels and block are assembled as in the figure.

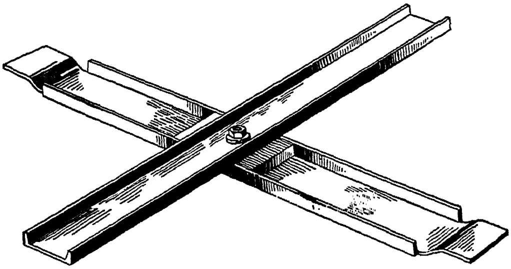


FIG. 74.—Portable staging of light-weight channels.

This channel-iron staging may be folded together to be handed through the furnace door, then opened up inside, as in the diagram. The ends fit on top of the brickwork at the lower part of the furnace, and a workman can reach all upper parts of the furnace from this staging with little danger of slipping.

Boston, Mass. HARRY M. SPRING.

203. Cause of Water Hammer in Bent-tube Boiler.

Feed water was delivered to our 1,500-sq. ft. bent-tube boilers through the top of the drum into a trough located about the middle of the rear drum. The feed line ended in a T having a short nipple in each end to deliver the water to each end of the trough. These nipples were below the top of the trough and were therefore always covered with water. One day, a bad case of water hammer developed in the feed line at the boiler. The check valve would have spells of clacking and snapping irregularly.

Whenever the fire was hot the water level in the glass would rise, and the snapping would begin, but when the fire burned low the water level would drop, and the water hammer would cease. It was found that when the water dropped below one-third of the glass the water hammer would occur. Since it was necessary to keep the boiler in operation for at least a month before it could be shut down and the trouble corrected, the water level was maintained around ½ glass.

When we shut down, we found that the trough had fallen down, leaving the nipples open to the steam space, except when the water was above ⅓ glass. As the feed temperature averaged around 150°F., and the steam at 125 lb. was 353°, steam was being condensed at the check valve, causing the water hammer, when the nipples were exposed in the steam space. When the nipples were under the water the steam could not reach the check valve, and it would work smoothly. When the fire was hot the front bank of tubes steamed violently and tended to draw the water to the middle and front drums. This caused the nipples to be submerged and exposed to the steam intermittently by the heaving of the water surface and resulted in the water hammer.

Medical Lake, Wash. CHARLES F. FORBES.

204. Gas Leaks into Boiler, Causes Explosion.

A boiler used for supplying steam to a gas generator was emptied to permit renewal of a fusible plug. The stop valve between the boiler and the generator was closed, a manhole cover was removed, and a man attempted to enter with a lighted candle. An explosion resulted. Fortunately, no serious damage was done. The stop valve between the boiler and the generator had been leaking, and when the water was emptied from the boiler, gas entered it.

It is important that stop valves used in these positions be kept steam- and gastight. As an additional precaution, the gas generator should have been disconnected from the boiler at a convenient place *before* the boiler was emptied.

Brooklyn, N. Y. S. H. Ashton.

205. Welding a Leaky Handhole.

We had been having trouble on a 72-in. by 18-ft. horizontal-tubular boiler. A 4- by 6-in. handhole had corroded so badly that there was a continuous leak. A ring 1 in. wide and ⅝ in. thick was set along the edge of the opening and welded in place. This has been in service for five years without leaking. The handhole cover seats against the ring and remains tight.

Watertown, Mass. Thomas A. Walsh.

206. Pointers on Making Boiler Manhole Joints.

Two common causes for leaking boiler manholes are use of too thick a joint ring and badly corroded faces on the cover and boiler. The thinner the ring or gasket used to make a joint of this kind the better. One of the best ways to repair corroded surfaces is to build them up by means of electric welding and finish them by grinding.

Our practice in making a manhole joint is first to clean the surfaces on both the cover and boiler, then to smear one side of the joint with white lead and place that side against the cover. The side that goes against the boiler is smeared with black lead, or graphite. This insures that the joint will part readily from the boiler and remain cemented to the manhole cover.

Brentford, England. W. E. Warner.

207. Loss of Steam through Small Drain Lines.

We are operating a sawmill where steam power produced from waste fuel is abundant. However, an addition of by-product machinery has loaded our three boilers considerably. Under the sawmill proper, there are seven drains from large steam mains supplying a steam-driven air compressor and other steam-driven apparatus in the mill. The drains are all connected to a large pipe extending 70 ft. or more from the mill.

We decided to install a sand dryer, and one of the small steam-line drains was disconnected and carried to the dryer. On disconnecting this particular drain from the main line, we found that the supposedly tight valve leaked badly. Further investigation, by disconnecting the various drains, showed even worse leaks. It is safe to say that sufficient steam to produce 50 to 60 hp. was being lost.

Connecting drains and small exhaust lines to a central drain may be good practice, but a check-up should be made from time to time to see if any steam is being wasted.

Butler, Tenn. W. S. WHITING, JR.

208. Evaporator Used as Reducing Valve.

Here is a means of utilizing steam at 300 lb. gage and 100°F. superheat for uniflow steam engines designed for a working pressure of 150 lb. gage.

One or more bent-tube evaporators of the reducing-valve type may be used to considerable advantage if

1. The uniflow steam engines exhaust to jet or barometric condensers, and the steam supplied to these units is not recoverable.

2. The boiler feed water has scale-forming characteristics, and considerable boiler and heat transfer troubles have arisen because of scale formation.

The advantages of bent-tube evaporators of the scale-shedding design, removable tube-bundle pattern, when used in place of reducing valves, are:

a. An evaporator, when controlled by a suitable regulating valve, will maintain a constant discharge vapor pressure.

b. The steam used to operate the evaporator (steam-fired boiler) to produce lower-pressure steam from the evaporation of raw water carried at a predetermined level in the shell can be returned to the boiler in the form of condensate.

c. The scale formation likely to take place is on a bowed-tube surface having the characteristic of scale shedding by the thermal-cracking process.

d. Evaporators are 100 per cent thermally efficient, except for minor radiation losses and during the periodic scale-cracking interval.

e. Evaporators may be designed to produce a certain excess amount of vapor above that required for the uniflow steam engines, this excess being condensed in an auxiliary condenser using evaporator feed as circulating water, and the required amount of low-pressure steam condensed may be returned to the steam in the form of condensate to be used as boiler feed-water make-up.

This arrangement will allow high-pressure boilers the advantage of operating on distilled water, thus reducing boiler maintenance and at the same time improving heat transfer.

New York, N. Y. R. W. MUNRO,
Engineer, Griscom-Russell Co.

209. Method of Eliminating Waste of Steam from Boiler Pop Valves.

In many industrial plants where power is generated and low-pressure steam is used for process and heating, much of the steam that under the conventional arrangement is escaping through the safety valves can be put to useful work.

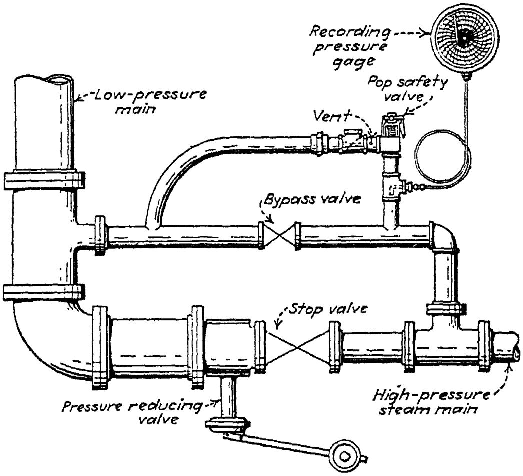


FIG. 75.—Pop valve connected to by-pass reducing valve and discharge to low-pressure main.

An arrangement that has worked ideally in one plant is shown in Fig. 75. A pop valve is shown by-passing the reducing valve. The pop valve is set to blow at a pressure about 1 lb. lower than the regular pop valves on the boilers. As the pressure approaches the popping point, this valve relieves first and usually discharges sufficient steam to keep the regular pop valves from opening. In this case, we are using a 2-in. high-lift pop safety valve. Normal boiler load is around 30,000 lb. of steam an hour at 160 lb. gage, and this size is working out very satisfactorily. It will also be seen that there is a 2-in. check valve on the discharge side of the pop valve. This is necessary because the low-pressure steam varies and would change the popping point of the valve, but by using the check valve and placing a small vent between the check and pop valve atmospheric pressure prevails in the body of the valve above the seat. This arrangement eliminates the effect of any change in pressure on the low-pressure mains, particularly effective where there is a sharp variation in the load and the noise of the pop valves is objectionable at night.

By placing a T below the pop valve, as shown, with a leading side pitot tube connected to a recording pressure gage, both steam pressure and the time and duration of the popping are recorded by a chart.

The effect on the morale of the operators is as great as, or perhaps greater than, the value of the steam saved. As an unquestionable record is made of the actual popping that takes place in the plant, steps can be taken to curtail it if the wastage is excessive. This arrangement is equally effective for recording time and duration of blowing when placed on the main pop valves of the boiler.

Rochester, N. Y. S. C. PAGE.

210. Repairing Steam-injector Nozzles.

The cause of any unusual wearing away of the parts of a steam injector is usually dirty steam, that is, steam carrying particles of scale. These particles cut away the metal at the top end of the nozzle, leaving the hole there too large. Enlargement of the nozzle gives the injector a large capacity, and that means the injector will not operate at such low steam pressure as it did when first installed.

When the nozzle has become considerably enlarged, a new one should be obtained, or the old one built up and reamed out. Repair is accomplished by filling the hole through the stem, as well as those around the top, with hard solder and drilling through. The whole nozzle should be cleaned well in muriatic acid; then the surfaces to be soldered should be fluxed with zinc-cut muriatic acid. When the hole has been built up it must be bored and reamed out, a tapered reamer being used to give correct shape to the nozzle.

Chicago, Ill. G. M. GEORGE.

211. The Lowdown on Blowdown.

We may set the limits for the use of the various methods of blowdown about as follows: Continuous blowdown is seldom justified where total blowdown is less than 3 per cent of the water evaporated. Where blowdown is over 3 per cent, and the concentrations to be removed are all or largely soluble salts, continuous blowdown with or without heat recovery should be considered. In boilers where sludge-forming material constitutes 50 per cent or more of the total solids in the feed water, and the total concentration is 4 gr. per gallon or over, the use of sludge deconcentrators should be given consideration.

Of course, we all agree that it is desirable to remove sludge-forming material from the make-up water outside the boiler so far as it is practicable. Experience has shown, however, that with many raw waters a treatment that will completely remove them will require the addition of so large a quantity of soluble salts to maintain a safe sulphate-alkalinity ratio that the total concentration will be raised to an extent that will require an unreasonably large blowdown loss. Therefore, the most economical, safe water treatment should be given careful consideration before deciding on type of blowdown.

New Haven, Conn. W. W. Gaylord,
Consulting Engineer.

212. When to Blow Down the Boilers.

In a plant with four 6,000-sq. ft. boilers, it had been the custom to blow down each at least one gage per day. We were convinced that a considerable saving would be realized if some provision were made for checking daily the concentration of water to avoid unnecessary blowing down.

We considered titrating daily samples with standard acid or with a solution of silver nitrate but finally decided on purchase of a specific-gravity apparatus which would indicate accurately one ten-thousandth increase or decrease in density.

A sampling cock was accordingly placed below the globe valve on each water-column drain line. Daily samples were taken from each boiler and allowed to cool to the air temperature. In taking specific gravity, we avoided a temperature correction by comparing the density of the samples with that of distilled water at the same temperature.

As no trouble had been experienced from priming or from the alkalinity of the water, we assumed that the average water concentration attained in the regular practice would be a safe minimum at which to start blowing down. For the purpose of a test, we continued blowing only three of the boilers and allowed the other to be filled with fresh water, watching closely for a dangerous increase in concentration. The water in the boilers being blown showed no tendency to rise above what corresponded to about 700 or 800 parts of mineral per million parts of water, and in the boiler not being blown down the water had barely reached that concentration when the time for the regular biweekly emptying arrived.

After a month of careful testing, we discontinued the daily blowdown entirely. We later found that once every two days was often enough to test the samples and that it was seldom necessary to blow a boiler between the regular bi-weekly emptying times. As to scale troubles, we believe these will be reduced also, for the chief scale-forming salt in the water is calcium carbonate. One of the peculiarities of this salt is that its solubility decreases as the temperature of the water is raised. It is thus evident that each gallon of hot water blown from the boiler will carry with it less of this particular mineral than will be brought in by the gallon of raw water required to replace it, for the raw water is saturated with calcium carbonate.

We believe the specific-gravity apparatus is more satisfactory than a titrating outfit would be, as it requires less skill and entails no periodic expense for chemicals. It costs only $24 and, with proper care, should last almost indefinitely.

Lake Charles, La. M. F. Knoy.

213. Blowing Down Boilers under Load.

I had 16 water-tube boilers operating at 275 lb. pressure connected to a common header feeding engines and equipment totaling 12,000 hp. It was often necessary to blow down some of the boilers while the load was on. My procedure was to bring the water level up about 2 in. above the normal line in the gage and then blow down while the boiler was being fed.

One must be rather cautious when handling the feed and blowdown so as not to cause rapid changes of conditions. Water level should be brought up slowly while maintaining normal steam pressure, and the level should be lowered by the blowdown in the same manner, that is, not so fast as to cause any change in steam pressure.

West Concord, N. H. C. H. Willey.

214. Slow Blowdown System for Boilers.

A blowdown tank capable of withstanding full boiler pressure and fitted with a steam gage and water-gage glass is connected to the boiler as shown in Fig. 76. The tank is first filled with steam to the pressure in the boiler by opening the steam valve. As soon as the full pressure is attained, the blowdown valve is opened, and water allowed to flow into the tank through the regular boiler blowdown. When the desired level has been reached in the tank, as indicated by the gage glass, these valves are closed. Then the drain valve and vent valve are opened, and the water allowed to drain from the tank. By determining the capacity of the tank and recording the number of fillings, an accurate check can be made on the amount of water blown down.

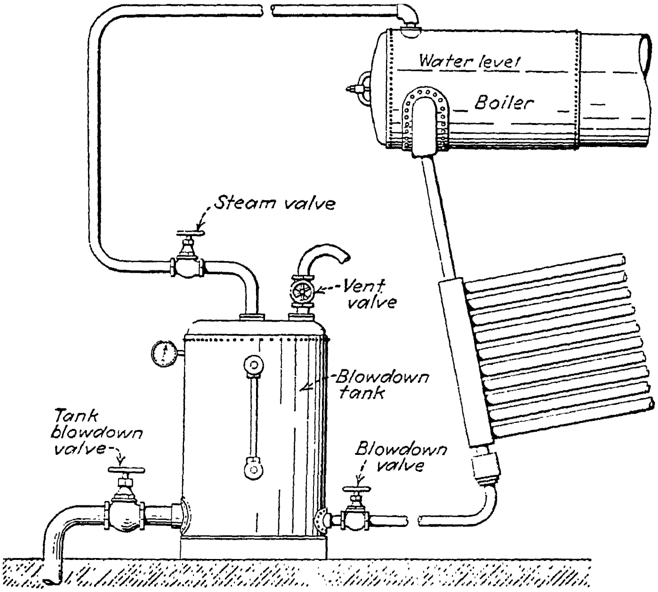


Fig. 76.—Boiler can be blown down under balanced pressure or at any pressure differential.

Where it is desirable to accelerate blowdown, this can be done by closing the steam valve and releasing some of the steam to atmosphere or heater. In this way, any pressure differential can be obtained between the tank and boiler, and the desired blowdown rate maintained.

Hertfordshire, England. W. E. WARNER.

215. How a Blowdown Problem Was Solved.

Our power plant is located close to a number of residences, and when first put into operation the blowdown was connected direct to the sewer. The sewer began to fill up with sediment, and the steam discharge became objectionable. The trouble was overcome by rigging up the blowdown tank illustrated in Fig. 77.

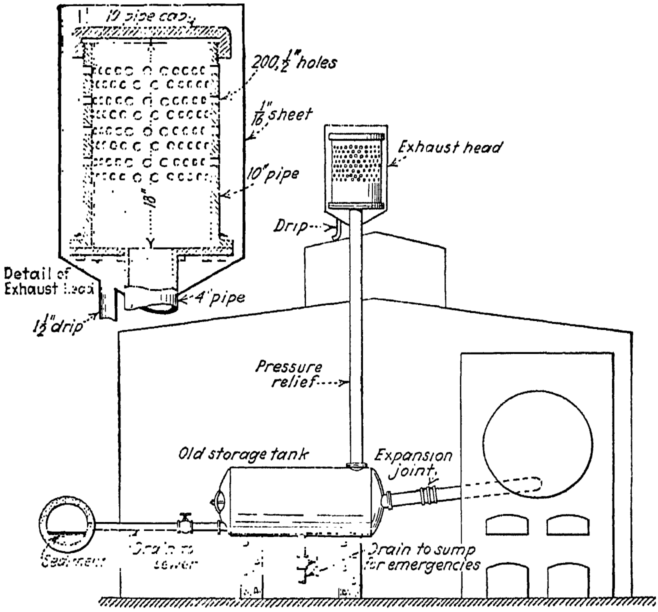


FIG. 77.—Exhaust head on blowdown tank lessens noise.

A feature is the exhaust head, which was designed to reduce noise at the time of blowdown as much as possible. Only a moderate hissing sound can be heard, which is not at all objectionable.

Mercersburg, Pa. JOSEPH H. FUNK,
Superintendent of Buildings and Grounds,
Mercersburg Academy.

216. Washer Shuts Down the Boiler.

The blowdown pipe on a return-tubular boiler developed a leak. Removal of the casing of the protective brickwork revealed a bad bulge in the pipe. In the middle of the bulge was a small opening where the metal had been burned through. The pipe was removed and cut through just below the bulge with a hacksaw. As luck would have it, the cut came a bare quarter-inch above the source of the trouble, a large washer lodged tightly in the pipe. Scale had lodged and solidified above the washer, leading to the bulge and the leak. The washer belonged to the manhole plate. The attendant who dropped it in while working on the boiler had failed to report the occurrence.

Rowayton, Conn. M. P. BAXTER.

217. Is It Safe to Blow Down Water Walls?

I never did like the idea of blowing down water walls of our boilers, but I found that the side walls had to be blown down, as all of the sludge rested on the bends of the tubes. In fact, I just caught the side walls in time to prevent burning of the tubes. Since then, we have blown down while under load. I brought up the question of blowing down's interfering with circulation, while the boilers were under construction, but we had to test it for ourselves.

We have two 10,000-sq. ft. boilers with side and back water walls. These boilers carry 350 lb. pressure, and the rating during the winter months is around 280 to 300 per cent of normal. During the night, the load drops to around 220 per cent. So far we have not experienced any trouble from blowing down the walls with the boiler in service, but at the same time we should like to operate without it if possible.

We use as much as 180 lb. of sodium phosphate each 24 hr. on one boiler to overcome scale troubles, and in addition we have to blow down to clear the sludge.

Montreal, Que. P. JONES,
Chief Engineer, C. N. R. Shops.

218-219. Two Procedures in Closing and Opening Blowdown Valves.

218. There is a definite procedure in opening and closing tandem-connected blowdown valves. When blowing down, the valve nearest the boiler is opened first. Then the outside valve is opened slowly to control flow. This valve is closed to stop flow. The valve nearest the boiler is then closed. By this practice, the valve farthest from the boiler is subjected to the greatest wear from water and scale. When this wear causes leakage or other trouble, the valve nearest the boiler will usually hold pressure until the outside valve can be repaired, if it is necessary to make the repair with pressure on the boiler.

219. This practice works very well where the first valve is a quick-opening disk or gate valve. Where two screw-plunger type valves are connected in tandem, the system of operating the valves, just described, may not work with entire satisfaction. Difficulty may be found in closing the valve nearest the boiler, because its plunger comes down on a column of water between it and the closed outside valve.

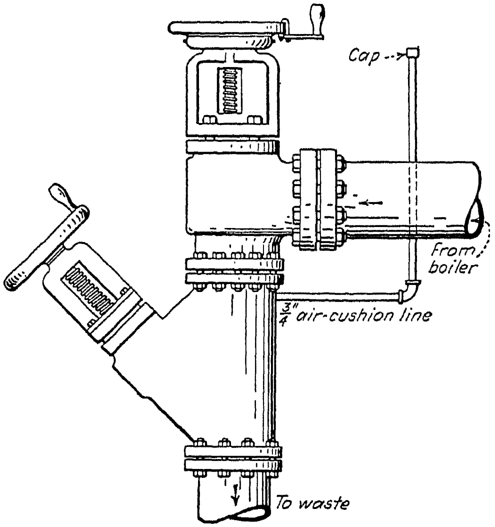


Fig. 78.—Relief chamber for blowdown valves.

This difficulty may be avoided by drilling and tapping a hole for a ¾-in. pipe thread in the connection between the two valves. A short length of pipe with a cap is connected in this hole, as in Fig. 78. This line then acts as an air compression chamber to prevent excessive hydraulic pressures between the two valves.

Boston, Mass. A. A. Fredericks.

220. Protecting Outside Economizer Blowdown Line.

Freezing of the blowdown line during cold weather after an outside economizer (Fig. 79) had been blown down caused considerable trouble. To prevent this trouble, a ½-in. line was extended from the plant compressed-air system to the economizer and tapped in to the blowdown line just below the blowdown valve. After blowing down, air pressure was turned on until the line was blown clear. This was indicated by a sudden drop in the pressure shown by the gage. Alcohol was used to fill the gage line and siphon to prevent freezing of the parts

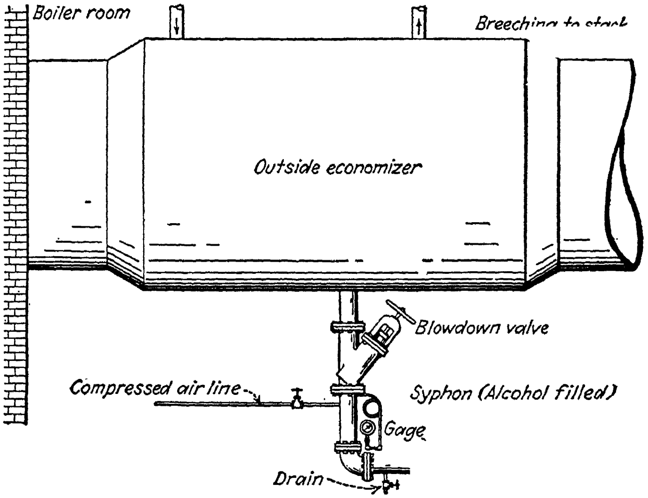


FIG. 79.—Two protections for outside economizer.

As further protection against freezing because of possible leakage through the blowdown valve, a drain valve was installed. This drain was opened after the air pressure was shut off to show if the blowdown valve was tight.

Milford, N. J. HARRY M. SPRING.

221-227. Seven Helps on Setting Superheater Safety Valves.

221. All the pressure drop through a superheater need not be allowed for in order to have the superheater valve blow first. If for any reason steam flow through the superheater is suddenly stopped, superheater pressure will instantly come up to drum pressure; so if the superheater valve is set at any pressure lower than the valves on the drum, it will blow first, which is as it should be.

222. Just how much lower the superheater valve should be set depends on how much pressure drop there is through the superheater, which will vary considerably with different-type superheaters and with the boiler rating and pressure.

223. With a boiler operating at 200 lb. and 200 per cent rating, pressure drop through the superheater should not be more than 7 or 8 lb. Therefore, operating close to the valve setting, which is the general rule in low-pressure plants, the superheater valve should be set at 204 lb., the first valve on the drum at 208, and the next at 210 lb.

224. On a boiler operating at 1,350 lb. pressure and extremely high rating and with a pressure drop of from 30 to 50 lb. through the superheater, about half the superheater pressure loss should be allowed for as with the low-pressure boiler, which in this case would be about 20 lb. Since the superheater pressure loss builds up faster with higher rating, it will also fall off faster, so it would not be necessary to lose half the load to cause the superheater valve to blow first. The superheater valve set at 1,380 lb. and the first valve on the drum set at 1,400 lb. should be correct.

225. With slag-tap furnaces as well as with stoker-fired boilers, radiant heat from the fuel bed or slag bed, as the case may be, generally will cause two or more valves to blow if the entire steam flow is suddenly stopped; but if the superheater valve opens first, the drum valves will blow for only a short period, after which the superheater valve will take care of all excess steam until normal steam flow is resumed.

226. Modern high-pressure boilers with water walls and forged drums should be brought up to working pressure slowly and with regard to temperature rather than pressure. If 3 hr. is used to bring a boiler up to 600 lb., less than 1 hr. more is all that is required to bring up a 1,350-lb. boiler. When high-pressure boilers are brought up to working pressure with a little regard to the temperature stress on the boiler and with the drain valve on the hot side of the superheater open, superheater temperatures will not be above normal.

227. Regarding the destructive power of superheated steam to safety valves, it is about 90 per cent imagination and does not exist. There is very little difference in the temperature of the safety valve whether steam is blowing through it or not. Tests have proved, and I have found from experience, that superheated steam does not cut so much as saturated steam.

South Amboy, N. J. R. SEPTOR.

228. Safety-valve Connection Fails on Superheater Header.

A superheater designed to operate with steam at 800°F. and 800 lb. per square inch failed at 675 lb. The header was of forged steel machined all over and was fitted with two pipe connections, one for the safety valve and one for a stop valve, connected to the header as shown in Fig. 80. They were serrated on the ends before installation and were bell mouthed on the inside of the header. Under a pressure of 675 lb., the joint between the safety-valve pipe and the header failed. The escaping steam made it difficult to shut off the steam, but no damage was done beyond destruction of the joint.

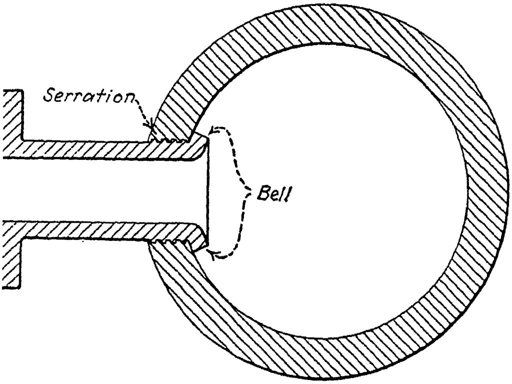


FIG. 80.—Serrated joint that caused trouble.

Investigation showed that the serrations had not been completely filled when the joint was expanded, and the bell mouthing was not considered sufficient for the pressure. It is open to doubt if serrated and bell-mouth joints are wholly reliable for high pressures. Alternate heating and cooling causes a certain amount of movement, and this may in time destroy the efficiency of the joint. The joint was remade by welding.

Hertfordshire, England. W. E. WARNER.

229. Traps Reduce Superheater Maintenance Costs.

In a large 400-lb. pulverized-fuel-fired industrial power plant, superheater headers gave trouble due to leaking. Located within the boiler settings, these headers developed leaks at the tube ends and around handhole fitting gaskets. Investigation revealed that condensation in the headers during banking periods caused most of the trouble.

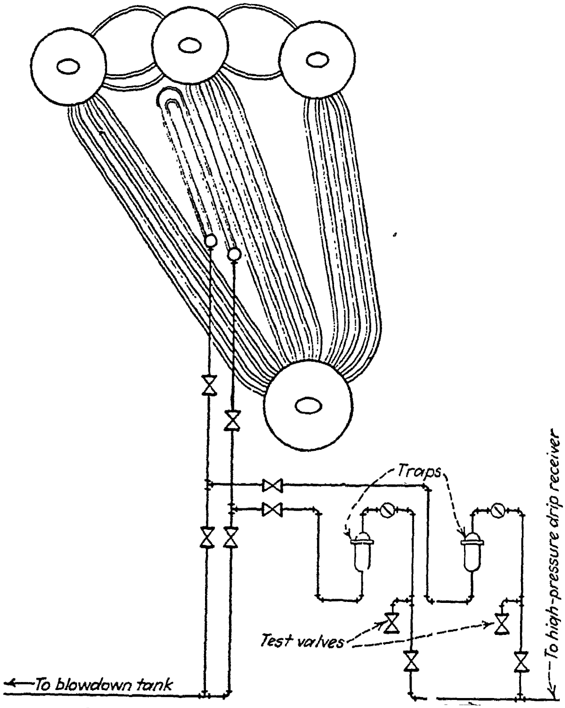


FIG. 81.—Traps drain superheater headers.

Inasmuch as cracking superheater drain valves during banking periods would result in excessive heat loss and high valve-maintenance costs, traps were installed to drain the headers, as in Fig. 81. The original drain valves were left in place so that the traps might be by-passed during firing periods to insure a flow of steam through the superheater and for draining, should it become necessary to repair the trap.

Waynesboro, Va. S. H. COLEMAN.

230-232. Three Tips on Use of Torch in Changing Superheater Tubes.

230. Changing the tubes of superheaters that have the loop ends expanded into a manifold is, in some installations, rather difficult. If there is an expert oxyacetylene torch operator available, then the quickest way is to cut each end of the loop fairly close to the header (about ½ in. away) so that the loop can be removed.

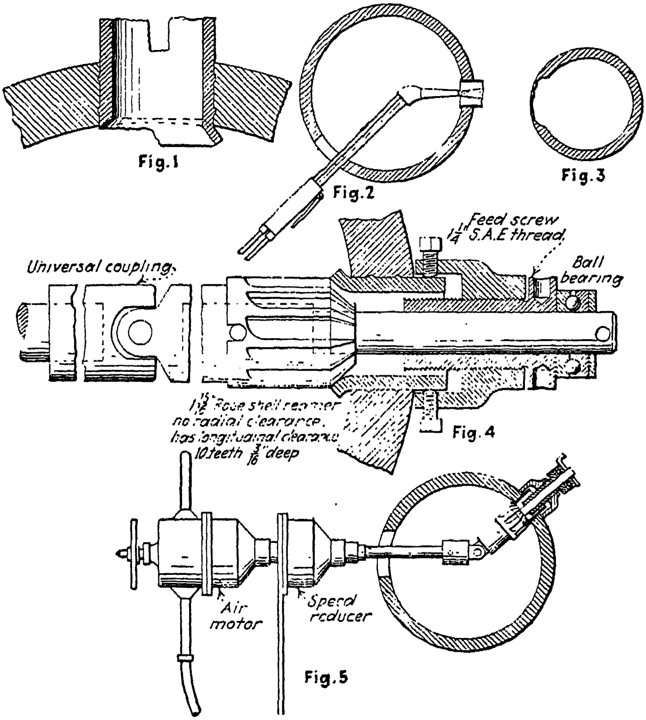


FIG. 82.—How torch and special tools are used in changing tubes.

231. The next thing is to remove the expanded ends, and it is for this that skill with the torch is required. First the bell of the tube is cut away as in Fig. 82-1. Then using a torch of suitable shape (one with a 45-deg. head may be right), the groove is cut on one side (Figs. 82-2 and -3) until the last remaining particle of the tube blows away from the seat, at one spot. The little that now remains in the groove will not prevent the easy driving out of the tube end. It will be seen by Fig. 82-3 that there is a gradual burning away of the tube surface until enough has been removed.

232. For such tubes as cannot be reached with the torch, or when there is no reliable torch operator available, I have designed the tool shown in Fig. 82-4. The drill, or reamer, is 1/16 in. smaller than the tube hole. This is a slower process than cutting out with a torch, but where only a few tubes have to be removed it is fast enough. The tube is first cut off about ½ in. away from the header by an internal tube cutter or by a torch; the use of the latter here requires only ordinary care. The drill is mounted as shown in Figs. 82-4 and -5. To reduce the speed sufficiently, the gear case of an old air motor was fitted up as shown in Fig. 82-5. This reducing gear has proved useful for other purposes—reaming large holes, etc.—where a slow-speed motor was not available.

Long Beach, Calif. E. J. JORDAN.

233-240. Eight Pointers on Installing Soot Blowers.

233. Although soot blowers installed in the first pass of a boiler will not entirely eliminate hand lancing for removing slag from tubes directly exposed to the fire, their use in this location has grown greatly in recent years and has proved fundamentally sound. Owing to the development of heat-resisting alloys, soot-blower elements are available that will successfully withstand temperatures encountered in the first pass, except under abnormal conditions. In horizontal cross-drum boilers, one or two units installed at the top of the first pass, and one unit between the first row of tubes as close as possible to the boiler headers, will be found in most cases to give satisfactory service and will cut the necessity of hand lancing to a minimum.

234. Steam is somewhat more effective for removing slag than is compressed air. This is because the steam is usually at higher pressure than air, also because steam attains a higher velocity than air when expanding from the same pressure. Maintenance costs are, in general, higher on steam-operated units, owing to leaks in the piping, packing glands, valves, and swivel tubes—troubles that do not develop when compressed air is used.

235. When installing soot blowers, care should be taken that nozzle spacing corresponds with the tube spacing and that the valves are properly timed. In maintaining soot blowers, special care should be taken to guard against sticking valves that may allow steam or air to enter the element after the blowing arc has been completed.

236. For removing dust and fly ash from the second or last pass of the boiler, gas reheaters, economizer, or air preheater, compressed air is as effective as steam and has the advantage of extremely low maintenance cost. Elements in these positions will last almost indefinitely, and swivel-tube wear is practically negligible if proper packing is used.

237. One of the principal causes of element failure is the sudden temperature change that takes place at the time that the unit is blown. This sets up severe temperature stresses because the inner surface of the tube wall is cooled suddenly when the valve is opened, while the outer surface remains at a high temperature. Temperature equalization scarcely has time to take place before the blowing period is over and excessive creep, grain growth, and embrittlement are caused. It is also a cause of warping, especially when one side of the element is somewhat exposed to radiant heat.

238. The cooling effect of expanding air is also a cause of trouble. The outer edge of the flared nozzle is cooled to a comparatively low temperature, and the nozzle, as a conductor of heat, also cools the tube wall directly around it. This rapid cooling and shrinking actually causes cracking of this highly stressed area, and after a crack is started it will generally open far enough in a short time to allow the nozzle to blow out. Such cracks, if found in time, can be filled, and the nozzle welded in place.

239. Examination of element failures invariably reveals that warping is more severe near the inlet end, and nozzle failures starting at the inlet gradually disappear, seldom, if ever, extending more than two-thirds of the length of the element. Nozzles near the dead end are nearly always found to be in good condition.

240. By using preheated air, temperature stresses can undoubtedly be reduced. To be effective, the air must be heated to a fairly high temperature, which could be accomplished by placing air-heating coils in the gas passage, probably adjacent to the economizer. Additional advantages would be a considerable saving in compressor power and an increase in capacity.

South Amboy, N. J. RAYMOND SEPTOR.

241-244. Four Pointers on Soot-blower Maintenance.

241. Although initial correct installation is of importance, since the elements are exposed to high and alternating temperatures, warping and displacement of nozzles are always possible. When the nozzles become displaced, blowing becomes inefficient, and erosion of the boiler surfaces may result due to direct impingement of the steam. Condition of the elements and position of the nozzles should be checked each time the boiler is inspected. Nozzles themselves should also be examined. If the nozzles become enlarged, they will waste steam, and steam blast will be less effective. Wear and enlargement of the nozzles are bound to occur, owing to the continual erosion of the steam, abrasive action of the flue dust, and other causes.

242. Efficiency of blowing also depends on a sufficiently high steam pressure; therefore pipe of ample size and full opening of valves during blowing become important. Considerable steam pressure may be lost through undersized piping or through use of piping which has become dented or otherwise mechanically damaged to reduce its cross-sectional area.

243. Frequency of operation of these blowers depends largely on the class of fuel used but also on other factors such as the efficiency of combustion and design of the plant. Blowing should not be delayed until deposits build up too much; otherwise deposits may be blown off in chunks and clog the spaces between tubes. In many plants, blowing every 8 hr. is adopted, but this time could in many cases be reduced with advantage, the increased efficiency of the heat transmission outweighing the slight increase in steam consumption.

244. Efficient blowing has a great bearing on efficient heat transmission. The increased boiler efficiency will usually more than repay the trouble and cost in maintaining the equipment in first-class condition.

Hertfordshire, England. W. E. WARNER.

245. Operating Soot Blowers with High-pressure Steam.

We have seven bent-tube boilers carrying 215 lb. pressure and 200°F. superheat and operated at 250 per cent rating, all equipped with soot blowers. Soot-blower elements begin to grow after about ten months' service. This growing continues until nozzles near the end of the element get too close to the edge of the next tube. We then readjust the element. This can be done about twice. It is then taken out and replaced. We get a maximum element life of three years, but some are good for only two. This would indicate that when inspecting soot blowers it is more important to look after alignment of the holes at the end of the element than just near the head.

Most of the growing seems to take place in the section holding the nozzles. If an element has over three nozzles missing, it is best to replace it, as its efficiency is very much reduced.

This trouble occurs at the top of the first pass and in front of the superheater. These are, of course, the hottest positions, but the elements are partially shielded from the flames. The foregoing experience has been with the best elements we could procure and has been repeated at least eight times.

Dixon, Ill. DONALD S. MCWETHY.

246. Blowing Soot with High-pressure Steam.

Our plant consists of two bent-tube boilers operating at 150 lb. pressure and equipped with the required number of blower elements. The boilers have been in use about six years, and sometime ago a tube developed a leak and had to be renewed. An investigation showed that one of the blower elements had slipped out of place about ¾ in. or else had been set that way originally. This allowed the steam to impinge upon the side of the tubes, and seven of them were grooved as neatly as it could have been done with a file.

Since the elements generally have to be set in the most inaccessible places in order to accomplish their purpose, it is a good plan to inspect them at regular intervals, particularly if high-pressure steam is used.

Helena, Mont. A. D. DUNCAN.

247-253. Seven Pointers on Overcoming Corrosion and Plugging in Preheaters.

247. To insure against corrosion, exit-gas temperatures from an air preheater should not be dropped below 250°F., which is close to the dew point of the usual boiler gases. In the majority of cases the installation of air preheaters may be justified with final temperatures of approximately 300°, but where the economic limit of final gas temperatures is below this point, especially below 250°, materials must be found which will satisfactorily resist the ever present tendency toward corrosion.

248. Where exit-gas temperatures are too low, moist deposits form on the upper, or cool, end of the tubes in a tubular air preheater. Dilute sulphurous and sulphuric acids are present in these deposits. As the deposits build up, they soon acquire sufficient fluid body to flow down the tubes in the case of an air preheater with upward gas flow. As these deposits flow down the tubes, or as gas temperatures increase owing to increased boiler ratings, they dry enough to be baked to the tubes. Then, sooner or later, the tubes are plugged solid, and, under the mass, corrosion is taking place. Steam- or air-jet soot blowers are undesirable for installation where exit-gas temperatures are below the dew point, not because they increase corrosion but because clogging is of such nature that it does not readily yield to soot-blower operation.

249. It has been claimed that steam soot blowers promote corrosion by coating the tube surfaces with moisture. This belief cannot be justified by fact. The water condensed from the steam required to operate an unusually large air preheater soot-blower installation does not exceed 2,400 lb. per 8-hr. blow. In most cases it is required to operate the soot blower but once every 12 hr. on the average preheater installation. This represents but a small percentage of the total amount of moisture carried over by the combustion gases.

250. In the case of good grades of Pocahontas coal, the moisture content is 0.76 per cent, to which must be added the water represented by the combustion of the hydrogen, which may be present in the coal to the extent of 4.2 per cent. It will be seen, therefore, that a boiler burning 12,000 lb. of coal per hour will carry over 37,040 lb. of water in 8 hr. from the fuel and its combustion alone. In addition, moisture present in the air required to complete combustion amounts to a considerable weight. At 60°F. and 50 per cent relative humidity, every cubic foot of air (0.076 lb.) contains 3 gr. of moisture. Figuring an average requirement of 17 lb. of air to complete the combustion of 1 lb. of coal, it will readily be seen that, at 7,000 gr. per pound, 9,650 lb. of additional water is introduced in 8 hr. This gives us a total amount of water introduced in the products of combustion of 46,690 lb., whereas under maximum conditions the soot blowers do not introduce more than 2,400 lb. in the same time, or but 5.1 per cent of the total moisture present in the gases of combustion.

251. That the small percentage of water introduced by a steam soot blower is not a factor in connection with corrosion is borne out by the fact that both steam and air have been used as the cleaning fluid without any apparent difference.

252. Clogging, under normal conditions—that is, where exit-gas temperatures are not under 300°—can be, and is, satisfactorily prevented by proper installation and operation of mechanical soot blowers.

253. In one instance at least, successful cleaning has even been obtained where exit-gas temperatures are 290° and slightly lower. Given sufficiently high steam or air pressure to impart proper nozzle velocities, a blower of the right design for each type of preheater, and systematic operation of the blower at proper intervals, an entirely satisfactory cleaning may be obtained. To my knowledge, in only two instances have unsatisfactory cleaning results been reported, and both of these were due to exit-gas temperatures below the dew point.

In one large central station, the tubular air preheaters were put into operation with no provision for cleaning other than the hand lance. The boilers were fired with pulverized coal and were run at very high temperatures, so that large quantities of fly ash were carried over into the preheater, and plugging was particularly troublesome. It was found necessary frequently to cut out the preheater at the end of a single week's operation to clean a large number of plugged tubes. On occasion, it was found necessary to pass a regular tube cleaner through the tubes to cut out the accumulation packed into them. The entire preheater was turbined on several occasions. A soot blower was installed, with the result that out of the total of 1,080 tubes making up the preheater only two were found to be plugged. No supplementary hand lancing whatever has since been needed on this preheater.

Detroit, Mich. G. L. DAVIS.

254. Pouring Baffles with Plastic Material.

About a year ago, we put a vertical baffle in combination with a part-way horizontal baffle in one of our boilers to get more surface exposed to the radiant heat from the natural-gas-fired furnaces.

We failed at putting in the baffle until we hit on the idea of using a 2½-in. canvas fire hose, which worked to perfection. A piece of 8-in. pipe about 3 ft. long with companion flanges on each end and blind plates, one of which had a pipe nipple threaded into it, was used in connection with an old 8-in. flanged T. The whole rigging was stood on end on top of the boiler brickwork, and the fire hose was connected to the pipe nipple through the side outlet of the 8-in. T, as shown in Fig. 83. The hose was led through the top inspection door near the baffle and directed down to the bottom of the baffle with a jointed rod that had one end flattened and bent at right angles and riveted to the end

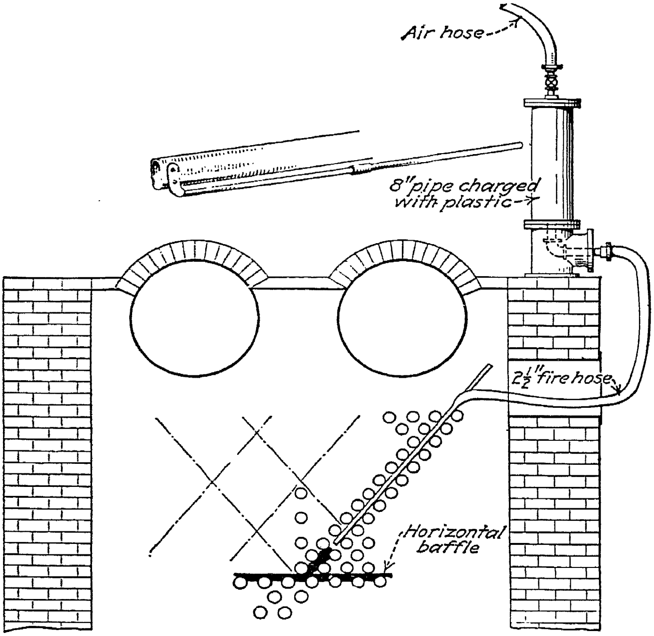


Fig. 83.—Arrangement for surfacing plastic baffle with fire hose.

of the hose. With the lattice in place and the hose spotted, the plastic firebrick material was made to flow into place by turning on air at 100 lb. pressure.

The plastic material, which was well mixed and soft but not so diluted as to allow it to segregate, flowed through the hose and filled every space around the boiler tubes. By moving the end of the hose to new locations, the whole baffle was made in a few hours.

Care has to be exercised when nearing the top of the baffle, for when the material has all passed out of the hose the air will rush out and splatter the material considerably.

These baffles have been in use about a year and are perfectly tight.

Laredo, Tex. W. F. Shutt.

255-260. Six Helps in Cutting Stand-by Plant-operating Costs.

In one plant, quite a reduction has been made in operating expense. It is required that this plant maintain hot stand-by service for a small capacity at least, to furnish steam to a near-by laundry as well as to maintain sufficient steam to operate the steam-driven spare city-water pumps in case of motor trouble or interruption to service. Of course, this service is also demanded in order that the generating station may be put into operation with the least loss of time.

255. When the economy program went into effect in the plant it was first found that a substantial reduction in the operating crew could be made. Fortunately, these men were able to be transferred elsewhere in the company.

256. The three turbine generators in the plant are served by a 10-in. steam header. With a few changes it was found that the auxiliary city-water pump turbine and steam-laundry supply could be fed from either of the two smallest boilers through a 2½-in. header. Accordingly, the larger header was cut out of service. The main header valve is easily accessible and requires only a short time to open. It is also equipped with a small by-pass equalizing line to increase the safety in opening the large steam valve.

Cutting out of this line eliminated all radiation losses as well as possibilities of leaks, and a considerable saving was effected. The two smallest boilers of the plant were piped with the small steam header, while the four large boilers were not changed in the least.

257. The question of firing next came up. Experience went against intermittent firing to maintain pressure. It was found that a saving could be made with a small yet constant fire maintained.

258. Here arose another question. With such a small fire maintained in the furnace of this boiler designed for a much higher rating, inefficient combustion resulted. The relatively cool walls of the furnace did anything but aid combustion. Having only 2,500 sq. ft. of heating surface, each of the two boilers were fired with one steam-atomizing oil burner. This same method was followed except for the fact that a burner with a much smaller oil slot was installed.

Then, starting at the front wall inside the furnace, a wall of firebrick was built on each side of the burner. These walls were only about 3 ft. apart at the burner and diverged toward the rear of the furnace. They extended the full length of the flame and were sufficiently high to retain it. Of course, the top and back between these walls was not covered. All in all, it amounted to a furnace within a furnace. These retaining walls, of course, remained hot during the firing period and aided greatly in increasing the efficiency of combustion.

259. Boiler feed water had previously been fed to the boilers by a group of three turbine-driven pumps. Any one of these pumps was large enough to handle almost any combination of boilers. Naturally, they were much larger than was desired on either of these two smaller boilers; therefore, injectors were installed on these two boilers and have worked very well.

260. But still closer maintenance on all steam lines, checking insulation, and operating the smallest available fuel-oil pump, still further economies were effected. In fact, with this combination of changes, the fuel consumed was reduced to one-third of the original value, and the investment was small.

Beaumont, Tex. R. F. SORRELLS.

CHAPTER IV

ENGINES

261-265. Five Causes of Pounding in Engines.

261. Looseness of journal boxes is the most frequent cause of pounding, which generally occurs as the crank passes the centers. If boxes are slack, pounding may heat the journal. This is especially true of crankpins. Stopping the engine and setting up the brasses usually will remedy a pounding crank. But the adjustment should be made gradually. The brasses may have become worn until their ends are in contact, so that they cannot be set up, in which case the ends should be filed down to permit proper adjustment. Calipering the pin and transferring the measurement to a pair of inside calipers, with which to measure the bore of the brasses, is the correct way to determine the amount to be filed off. It is good practice to file off enough to give an opening between the brasses, when they are in place, of from 1/8 to 3/16 in. The opening may be filled with thin liners. Then when the brasses become loose on the pin again they can be slackened, and a pair of liners removed. The boxes of shaft journals may be set up without stopping the engine, provided they are safely accessible.

262. Pounding may be due to a loose piston or to slugs of water entering with steam. Piston-rod nuts seldom work loose, because of the general practice of putting a cotter pin through the rod end behind the nut or a setscrew through the nut. Priming of the boilers is the usual cause of water's entering an engine cylinder. When this occurs the cylinder cocks should be opened and should be left open until the priming is checked. If operating conditions permit, the priming may be allayed by closing the throttle just enough to diminish engine speed slightly for 5 or 10 min.

263. Pounding may be caused by the piston striking the cylinder head. This often occurs in old engines in which connecting-rod brasses have worn. The connecting rod may be so designed that keying up the brasses has the effect of lengthening or shortening the rod. The remedy is to restore the normal length of the rod by inserting sheet-metal liners behind the brasses. The piston rod may be unscrewed from the crosshead. The rod backs out gradually, so that a long interval elapses before it is out far enough to cause serious trouble. Ample warning thus is given.

264. A frequent cause of pounding not so easily recognized is improper setting of valves, producing insufficient compression or insufficient lead; cut-off too early in piston stroke; and release too late. Reducing compression invites pounding; but too much compression puts too great a resistance against the crank, tending to cause unsteadiness in crank velocity. Insufficient lead is a common cause of pounding. Generally, high-speed engines require more lead than slow- or medium-speed units. With insufficient lead, the piston is brought to rest with a jerk. A similar effect is produced when release is late. The ideal condition is when the pressure is the same on both faces of the piston at a point in the stroke just in advance of the opening of the steam valve. This point is determined by the speed of the piston and by certain conditions which only the indicator can reveal.

265. Pounding in a condensing engine may be due to a high vacuum which does not allow sufficient cushion for the piston.

St. Louis, Mo. A. J. Dixon.

266. Eliminating Header Vibration.

To eliminate serious vibration in a steam header leading to an engine, I suggest inserting a sheet-steel diaphragm with an opening one-half that of the pipe, at a flange joint near the header; or, in case a receiver is already installed, placing the diaphragm at the receiver.

Take a steam-pressure diagram before and after, and, if the throttling effect is noticeable, enlarge the opening in the diaphragm. In several instances, this method has eliminated vibration, and the surprising thing about it is the fact that it caused little difference in the steam pressure at the steam chest.

A receiver should always be used near the throttle of any engine, but it might be necessary to put in a section of larger pipe to act as such if a regular separator or receiver is not available.

Coxsackie, N. Y. Lancelot Copleston.

267. Trip Hook Would Not Hold.

The trip hook on one of our Corliss engines kept slipping off the catch block on the head-end steam-valve crank, preventing the admission valve from opening properly. The trouble could be remedied temporarily by changing the hook and catch blocks, but in a short time the hook would slip off again.

We found that the catch-block stud had become loose enough in the steam arm to allow it to turn slightly toward the hook, as shown exaggerated in Fig. 84. After we turned the catch-block stud back to its proper place and secured it there, the trouble disappeared.

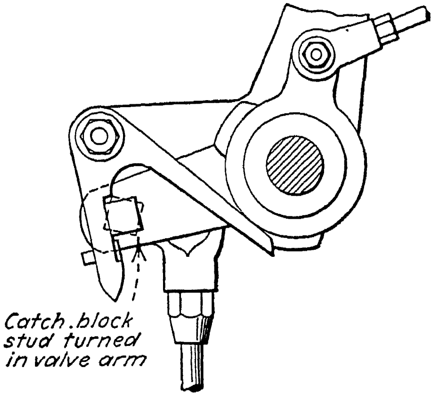


Fig. 84.—Turning of stud allows latch to slip off.

St. Mary's, Ohio. EARL STONEROCK.

268. Metering Steam to Engines.

Any flow-metering device installed in a pulsating flow will register a higher flow than the actual. An attempt to measure the steam flow to two reciprocating engines resulted in readings practically valueless, as the degree of error varied with the load on the engines.

The meter was the orifice type with an electrical recording mechanism. The orifice was installed in a 12-in. pipe about 70 ft. from the nearest engine. A 10-in. pipe was connected between the 12-in. pipe and an 800-hp., 28 by 48 Corliss engine running at 105 r.p.m. A 5-in. pipe was connected between the 12-in. line pipe and a 200-hp., 15 by 16 uniflow engine running at 265 r.p.m.

It was found on test that the large engine was the offender, as the meter gave accurate results when measuring the steam flow to the small engine alone. A large receiver was then installed in the 10-in. pipe line just above the Corliss engine. The meter then registered the correct flow with both engines running and checks a meter of the same type (within 2 per cent) in the feed-water line to the boilers.

Memphis, Tenn. G. HOFFMAN.

269. Removing Engine Crankpin.

A method we used recently to remove a crankpin where facilities were somewhat limited is shown in Fig. 85.

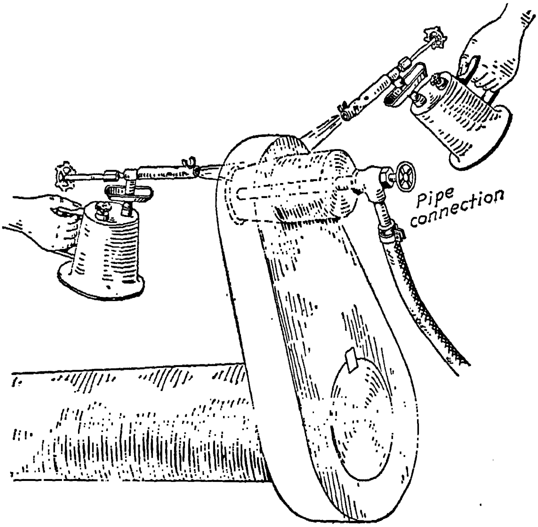


FIG. 85.—Web heated with torches while pin is water-cooled.

As the engine was in a light plant, the longest that it could be out of commission was 12 hr. The beading was cut off the back, and a hole drilled through the old pin for a ½-in. cooling-water supply pipe. The web was heated on both sides with blowtorches, and two solid blows loosed the pin in the taper.

The new pin was inserted at once while the web was hot, and as soon as the web had cooled down it was beaded over. The complete job required only about 8 hr.

Flint, Mich. GEORGE JACOBS.

270-271. Two Repairs on Loose Liners.

270. A successful repair was made on a loose high-pressure cylinder liner of an 800-hp. vertical compound engine. Trouble was first noticed by steam leaks at the pegs securing the liner to the cylinder. These holes were also elongated, the pegs were loose, and a loud click was heard as the engine crank passed dead center.

After fitting several sets of increasingly larger pegs without effecting a permanent repair, it was realized that a different method of securing the liner was necessary to cure the trouble. It was finally decided to remove the liner for examination. It was found to be 0.023 in. smaller than the cylinder, and the cylinder was 0.008 in. out of round, making a total clearance of 0.031 in. in places. Grooves were cut into the liner at each end, three in the top and two in the bottom, as in Fig. 86, at left. These grooves were made ¼ in. wide and ⅛ in. deep, and into them was hammered soft copper strip. These rings were finished in a lathe so that the copper was 0.018 to 0.02 in. above the face of the liner.

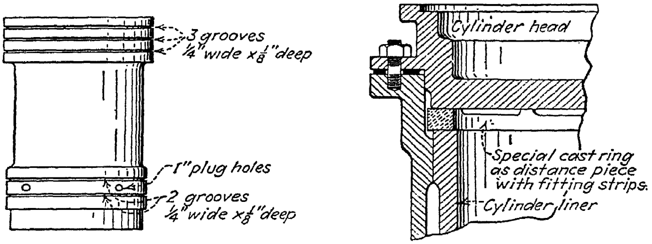

3 grooves ¼" wide x ⅛" deep
1" plug holes
2 grooves ¼" wide x ⅛" deep
Cylinder head
Special cast ring as distance piece with fitting strips
Cylinder liner

FIG. 86.—Two repairs on cylinder liners.

After painting the finished job with "Smooth-on" to insure steamtightness and preheating the cylinder with steam to expand it, the liner was pulled back into position. No further trouble has been experienced, and the work was completed in two days at one-sixth the total cost of reboring and fitting a new liner.

271. Another case of trouble with a loose liner occurred in a similar type of engine, but this time the liner was not removed for examination before making the repair. A special ring was cast as a distance piece and placed between the top end of the liner and the underside of the cylinder cover, as at right. This ring had strips cast on so that it could be accurately and easily held in position without throwing undue stresses on the cylinder-cover flange studs, which hold the liner in position.

This method requires careful fitting of the ring to insure success. Although it may not be good engineering practice, it may be justified for quick repair.

Blackburn, England. J. CASSIDY.

272. Leveling a Horizontal Engine.

Place the engine bed on the foundation over the anchor bolts. Then place the leveling wedges, three in number, one on each side of the bed at the cylinder end, the other at the crank end near the center. Next, place a true spirit level on the bottom of the crosshead guide and adjust to this level by means of the wedge at the crank end. Then set the bottom half of the main bearing in position, put a true spirit level on the bearing, and adjust for level by driving the wedges on either side at the cylinder end.

Next, place the shaft in position and level and square it with a line through the cylinder and crosshead guide. Recheck the bed and shaft for level and, when found true, place additional wedges under the bed to retain the true level. Then grout the bed in that position.

San Angelo, Tex. M. G. McCULLOUGH.

273. Securing Engines on a Rock Bed.

I encountered, at a mine, an engine loose on the foundation and which had to be secured with braces until it could be removed and the bolts reset. It was later found that the bolts were placed in a thin concrete slab placed on rock.

When we reset the engine, larger holes were drilled through the concrete and extended down into the bedrock about 12 in. The lower ends of the new bolts were split and ragged. When grouted, these held the engine securely.

Scranton, Pa. F. NEUMAN.

274. Engine Tightened to Foundation with Reinforced Concrete.

The bedplate which supported the engine moved on the foundation about ⅜ in. on each stroke. If it had any holding-down bolts, they were on the inside and could not be tightened without dismantling. The engine could not be shut down long enough to take it off the base to tighten bedplate bolts. It was therefore decided to anchor with reinforced concrete.

This operation consisted of digging away from around the foundation about 12 in. deep and 4 ft. wide, as far as it was considered safe to go without danger of loosening the foundation. Three channels about 4 in. deep by 10 in. wide were cut in the foundation top so that concrete could be worked up inside the bedplate. The engine was shut down one Saturday at noon and leveled and aligned with its generator by driving steel wedges between the bedplate and foundation.

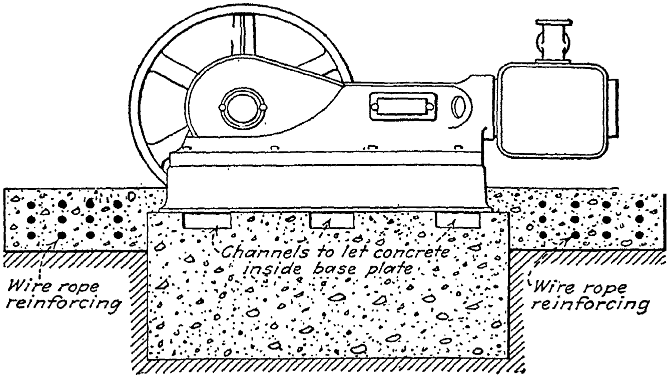


FIG. 87.—Engine tightened to foundation with concrete.

Concrete was then poured around the foundation about 18 in. deep and 4 ft. wide, as shown in Fig. 87. This concrete was reinforced with old wire rope. Concrete was poured in layers about 3 in. thick, with several turns of the rope around the foundation between layers.

Short pieces of rope were thrust up inside the bedplate through the channels to tie the concrete inside the bedplate with that on the outside.

The surface of the concrete was brought up to about 6 in. above the top of the old foundation and worked well into the inside of the bedplate by tamping. By Monday morning, the concrete was set sufficiently hard to allow starting the engine.

Atlanta, Ga. A. M. CARTWRIGHT.

275. Regulating Device for Corliss-engine Dashpots.

The dashpots of a 350-hp. Corliss engine were a continual source of annoyance. There appeared to be something wrong with the admission and release of air beneath the dashpot plungers. No adjustment of the air cocks would hold the dashpots noiseless within a reasonable range of load fluctuation.

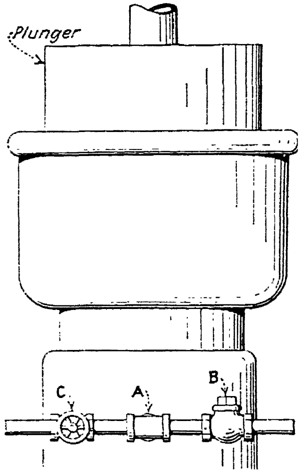


Fig. 88.—Globe and check valves replace air cock.

At length, the operating man decided to remove the air cocks and try the device in Fig. 88. It worked satisfactorily.

Short ¼-in. nipples were screwed into the openings *A* left by the discarded air cocks. A T on the end of each nipple branched one way to a ¼-in. check valve *B* and the other way to a ¼-in. globe valve *C*. The check valve was set to open outward. The degree of opening through the globe valve necessary to secure quiet operation of the dashpot was found by trial. Then the packing nut was jammed up tight to lock the stem in the position needed to preserve that opening. Even though load on the engine varied through a wide range, no readjustment of the globe valve was required.

As the dashpot plunger descended, air beneath it escaped through the globe valve as well as through the check. Thus the opening for escape was greater than the opening for admission, and by altering the disparity between the two openings any degree of cushion could be obtained.

St. Louis, Mo. D. J. Altizer.

276. Repairing a Fractured Valve-chest Cover.

A bad fracture occurred in a valve-chest cover on a reciprocating engine. The crack passed through a stud hole and extended for about 9 in. in a practically straight line.

Repair was made by fitting a ¾-in. plate over the fracture and securing it by four ¾-in. bolts on either side. A steel plate of the required size was marked off and drilled, no clearance being allowed for the studs.

The plate was heated red-hot, and the pitch of the holes in the plate measured to determine the amount of expansion. A template was made, the pitch of the holes corresponding with the pitch of the holes in the hot plate. This template was used to mark off the stud positions on the valve chest. After the studs had been fitted, the crack was filled with iron cement, and the plate was made red-hot again and put in place on the studs. As the plate cooled down, it tended to draw the cover together, the nuts being tightened as it cooled. When the cover was replaced it was tight, largely owing to the efficiency of the shrink fit obtained.

Hertfordshire, England. W. E. WARNER.

277. Reducing Power of Low-pressure Cylinder.

In compound steam engines, changing the point of cut-off in the high-pressure cylinder effects a change in the power developed in the engine as a whole. But to change the relationship between the powers in the individual cylinders, a change in point of cut-off should be made in the low-pressure cylinder rather than in the high-pressure. With a given engine developing a certain power, if it is desired to have the low-pressure cylinder carry more load than at present, then the cut-off in that cylinder should be decreased, which, in turn, builds up the receiver pressure, increases the mean effective pressure, and, at the same time, increases the back pressure in the high-power cylinder and so reduces the power in that cylinder. Total power remains the same.

Brooklyn, N. Y. CHARLES J. MASON.

278. How Piston Wear Was Reduced.

Our 29- by 30-in. high-speed side-crank steam engine had given satisfactory service for several years, but about five years ago the superheat was increased about 50°F., after which the bull ring began to wear down. As the ring had three positions, we shifted it from one to the other until it was worn on all positions. Then we ordered a new one. The new ring did not wear any better than the old.

After trying all kinds of cylinder oils to no purpose, we decided that the ring was not wide enough to resist wear. To increase the width we cast a ring 3½ in. wider than the one in use. We then turned down the back flange of the piston and the follower 3½ in. in diameter so the bull ring would extend over them. The steam rings were placed as far apart as possible, and a recess was cut in the space between them. A brass ring was then made to fill the recess and riveted to the cast-iron bull ring. With this ring we have had no further trouble.

Mechanicsville, N. Y. GEORGE W. CLARKE.

279. Improved Pistons for Small Steam Engines.

Whenever a piston has to be overhauled so much that new castings are required, one shop replaces the older type with a lighter and simpler design. Quite often a new piston will be almost as cheap as replacement of a bull ring or follower plate alone.

This shop replaces all solid and built-up pistons with what is termed a "box" piston, as shown in Fig. 89. This was a popular design when locomotives were smaller; it is simple, strong, and not expensive to make. For stationary-engine jobs, the shop follows this practice up to 16-in. diameter pistons. Snap rings are used, and they prove as satisfactory as the rest of the job.

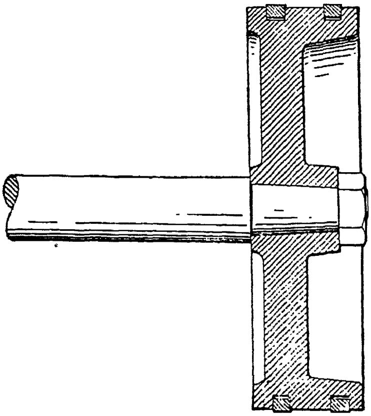


FIG. 89.—Box-type replacement piston.

Middletown, N. Y. DONALD A. HAMPSON.

280. Proper Adjustment of Crankpin Box.

Figure 90 shows a wedge block of 6 in. per 1 ft. scale. To determine the displacement of the block, it is not necessary to draw in the dotted lines *AFG*. Simply draw indefinite lines *B* and *C* at right angles. Place wedge block fair with these lines as shown and draw a line around its edges. Move the block along line *C* 1 in. and draw another line along *H*, producing dotted line *G*. Then measuring *HG* parallel to *B* will give the displacement of the wedge block per inch—in this case ⅛ inch.

Next, measure the pitch (number of threads per inch) of the adjusting screw, which in this case is 10. Then, with a pencil place a mark on the rod fair with one of the angles of the head of the screw, which is usually a hexagon. Turning 10 complete turns, therefore, will displace the wedge 1 in. and, of course, displace the wedge half of the box ⅛ in., or 0.125 in.

Then if only one complete turn of the screw is made, a displacement of $\frac{1}{10} \times \frac{1}{8} = \frac{1}{80}$ in., or 0.0125 in., will result.

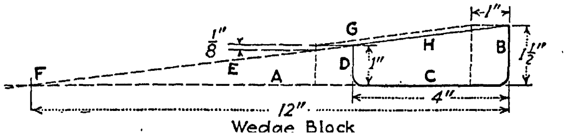


FIG. 90.—Wedge block of 6 in. per 1-ft. scale.

Likewise, if the screw is turned only one hexagon, or ⅙ turn, a displacement of $\frac{1}{480}$ in., or 0.002 in., will result. And with one-half hexagon, a displacement of $\frac{1}{960}$ in. is obtained, or a little more than 1/1,000, or 0.001 in., which is ample refinement.

The underlying thought may be carried into various angles of adjustment, as, for instance, the adjustment of the "quarters" of a crankshaft bearing.

Granite City, Ill. WILLIAM PITTMAN.

281. Emergency Cylinder Head for Steam Hoisting Engine.

I was confronted with the breakdown of an Alaska gold-mine hoisting engine, with the cylinder head blown off and broken in several pieces. We were far away from a base of supplies and did not have proper facilities for making out-of-the-ordinary repairs. To send to the manufacturer for a new head would have required five weeks.

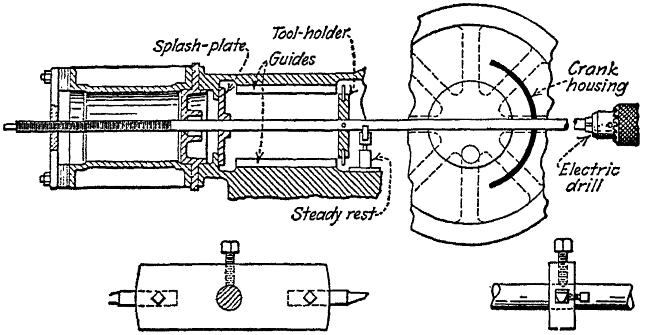
One miner suggested that we put on a wooden head in place of the one broken. I made longer studs to make up for the increased thickness of the wooden pieces, two of which were used. The pieces were put together with the grain of the wood of one piece running vertically and of the second piece running horizontally. The job was completed in less than 3 hr., and operations were resumed.

Butte, Mont. RALPH E. MACKAY.

282. Reboring Crosshead Guides of High-speed Engine.

The job consisted of reboring the crosshead guides and relining the crosshead on an old Ball engine.

The splash plate was rebored a few thousandths larger to give a running fit for a piece of line shafting 3 ft. longer than the over-all length of the engine, as in Fig. 91. Then the shaft was threaded, 32 threads per inch for about 3 ft., on one end. Another running fit was made by boring a hole in the far end of the crank housing, in line with the hole in the splash plate and the axis of the crankshaft bearings. A piece of ¾-in. bar stock was drilled and threaded to fit the threads on the shaft. This piece, when bolted to the cylinder, served as a means of propelling the shaft back and forth. A steady rest from a small grinding machine was bolted to the inside of the crank housing just beyond the guides and on the side opposite the splash plate.



Tool-Holder

FIG. 91.—Section through engine, showing how boring bar was supported.

A tool holder, as shown in the detail, was then clamped on the shaft, and a portable electric drill was used to turn the shaft. By attaching the drill first on one end and then on the other, the boring tools were moved back and forth, and the guides were machined. Polishing was done by screwing a lapping block to the tool holder, emery cloth and a regular grinding compound producing a satisfactory finish.

The remainder of the job was fairly easy. The crosshead was turned down about ⅛ in., and ⅜-in. brass plates were bent and machined to fit. After the plates had been screwed on, they were turned down on the outer surface to give proper running clearance.

Bethlehem, Pa. R. N. YOUNGBLOOD,
Department of Mechanical Engineering,
Lehigh University.

283. Lock Washer for Piston-rod Nut.

We found a piston loose on the rod. The nut evidently had backed off but, on account of abused threads, had stopped about 1/16 in. from the piston.

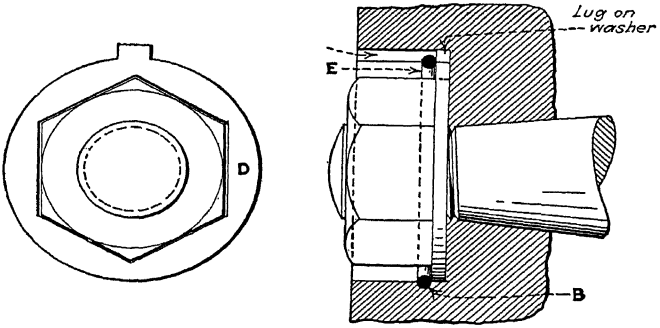


FIG. 92.—Lock washer fits over hexagonal nut on piston rod.

When the piston was taken out for the fitting of new rings, we put it in the lathe and turned out a groove *B* as shown in Fig. 92, and we also cut keyway *C* to take a lug of the lock washer to hold the nut.

The washer *L*, of 1/8-in. sheet iron, was made and put on after the nut was tightened up on the rod. It was filed down to fit closely on the nut and in the keyway. A spring *E* was expanded in the groove to hold the washer in place.

Ironton, Minn. A. LEKSTROM.

284. Copper Wire for Cylinder-head Gasket.

The crank-end cylinder-head gasket on a 28- by 48-in. Corliss engine failed. There was no time to install a sheet gasket, so we decided to substitute copper wire.

All studs in the crank-end head were removed, and the cylinder was jacked back about 1 in. to permit cleaning the gasket faces with small hoelike scrapers. The cylinder was then moved back into place with only sufficient space between gasket faces to insert a single strand of a special belt lacing (soft copper wire). By the use of hack-saw blades, this copper wire was worked down to the bottom of the space, one turn on top of the other, until nine turns were in, making nearly 1 in. in all.

The studs were then replaced and drawn up tight. We had a tight joint, which has been in service over three years.

The repair was made for $5, as compared to about $50 for installation of a sheet gasket, which requires at least 24 hr. time.

The copper wire should be pulled tight, as it is worked down in the space, to avoid any slack's keeping the next turn from going down to the proper place.

Olympia, Wis. CURTIS L. OVERLY.

285. Repairing a Cracked Engine Frame.

Power was transmitted from our 16-ft. engine flywheel to the main drive shaft in the mill by a 33-in. belt with a belt tightener on the lower side. Increased load caused excessive strain on the frame of the engine, and one day the frame cracked, as shown at *F* (Fig. 93). The crack, 12 in. long, ran through two bolt holes that tied the frame to the cylinder.

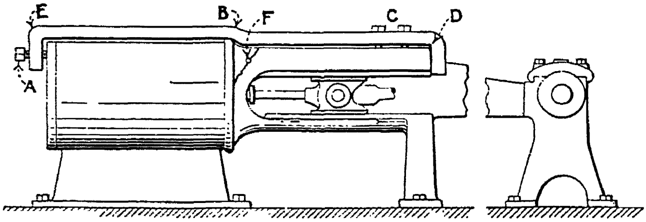


Fig. 93.—How the frame was stayed.

A templet was made to conform to the engine cylinder and frame. Then the blacksmith forged a piece of railroad iron 6 in. wide and 3 in. thick, bent at right angles at *E* and *D* and also bent in at *B*. While the support was being made, the millwright squared the guide at *D*. Two bolts at *C* were used to tie the bar to the frame. One cylinder-head bolt was removed, and the bar dropped into place. The bar was drilled and tapped at *A* for a 2½-in. bolt, which was screwed against the cylinder head, thus relieving the strain on the frame where it was cracked. A hole was drilled and tapped in the crack at *F* for a ½-in. stud, to keep the two edges of the crack from working. The accident happened at 2:30 P.M., and the following morning at 7 A.M. the engine was running again.

North Cambridge, Mass W. A. Dow.

286. Hints for Using Reducing Valves in Steam Supply to Engine.

In a manufacturing plant, the boilers delivered steam at 200 lb. to the main engine, but it was found necessary to run an auxiliary engine with steam at 100 lb. The reducing valve in the steam line leading to this engine was of the diaphragm, spring-loaded type. The reduced pressure, impinging on an internal diaphragm, was automatically maintained constant by the resistance, transmitted through a toggle joint, of the external spring.

One day, the auxiliary engine speeded up under almost full boiler pressure. Examination of the reducing valve showed the bearings of the toggle mechanism fouled with rust and sooty deposits from the air. Kerosene, followed by lubricating oil, into each movable joint, put the apparatus back in service.

Reducing valves sometimes prove unsatisfactory in engine service because they are too large for the work required. If the velocity of flow past the seats is nine times the normal velocity in the pipe, an actual opening equal to about one-ninth the cross-sectional area of the pipe should be sufficient to pass the requisite quantity of steam. If the regulator is of such size that its lift must be scant to produce an opening no greater than this, and it is placed close to the engine, the valve disks will tend to open and close rhythmically with the admission and cut-off of the steam, and there will be a violent hammering on the seats. And even if the oversized regulator is set far enough away from the engine to minimize these pulsating effects, or they are avoided altogether by installing a receiver between the engine and regulator, so as to provide a cushion for absorbing them, there will be excessive wire drawing through the slight openings and consequent scoring of seats.

There is no difficulty in reducing, in a single stage, from a high boiler pressure to any delivery pressure desired, provided the valve selected is suitable as to size and design. It is important that a strainer be inserted on the inlet side to protect valve disks and seats against obstruction and injury by particles of scale and other foreign substances that may be picked up by the steam current.

St. Louis, Mo. A. J. Dixon.

287. Hints on Truing Up Engine Crankpin and Shaft.

We purchased a rebuilt engine. The crankpin proved to be out of parallel with the crankshaft about 1/64 in.

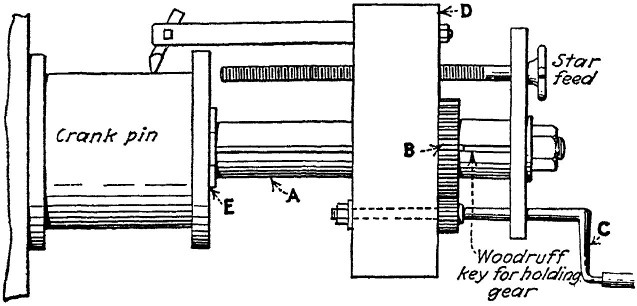


Fig. 94.—Machine used to true up crankpin.

As there was no machine available for truing up the crankpin, some means of doing it on the job had to be devised. Figure 94 gives an idea of how it was done. Sleeve *A* and gear *B* are stationary, and the crank *C* with pinion attached extends through block *D* and revolves around gear *B*. Shims were used at point *E* to offset the machine the amount the pin was cocked.

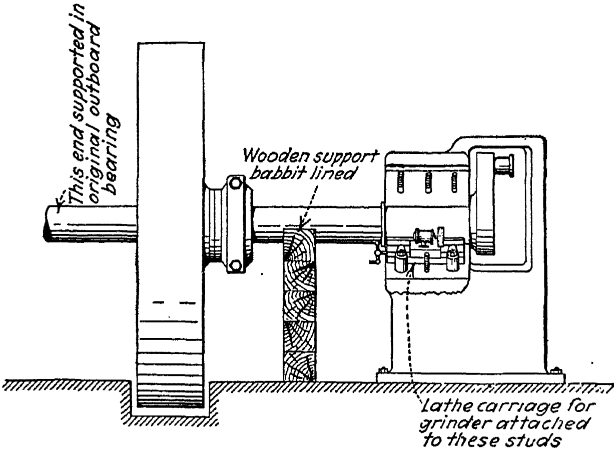

This end supported in original outboard bearing
Wooden support babbit lined
Lathe carriage for grinder attached to these studs

Fig. 95.—Grinder in place for work on crankshaft.

There was considerable doubt as to the crankshaft's being straight close to the crank disk, as in calipering it showed a taper and flatness, so when truing up the crankpin a point near the flywheel was taken where the shaft was round.

After operating the engine again, it was soon discovered that all troubles had not been overcome, and the next process was to check for a sprung crankshaft. The engine was in line, but the crankshaft ran out 0.012 in.

The crankshaft was jacked out of the main bearing and placed in the temporary bearing, as shown in Fig. 95, and the outboard bearing was also raised to bring it to a level position. In that position, the shaft proved to be out as much as 0.021 in. near the crank disk.

We decided to true up the shaft in place. The machinists fitted a tool post and carriage long enough to travel the full width of the main bearing. This was bolted to the main bearing. An old gas engine was used as a countershaft for speed reduction, and a 1,200-r.p.m. motor for the drive. The motor was belted to the gas engine, and the gas engine to the flywheel on the shaft, giving a final speed of 38 r.p.m.

The improvised tool post and carriage were considered too weak for a cutting tool, and a high-speed grinder was used instead. The shaft was ground until the 0.021-in. throw was taken out. When the engine was assembled it gave no further trouble.

Chattahoochee, Fla. J. L. DAVIS.

288. Measuring Clearance Volume of a Corliss Engine.

Recently I had occasion to measure the clearance volume of an 8- by 18-in. Corliss engine in connection with a test run to obtain data from which a Hirn's analysis could be made. It was not possible to obtain the clearance volume from the engine builders.

First we removed the cylinder head. As was to be expected, it was not feasible to calculate the clearance volume from the measurements taken, owing to the irregular shape of the steam and exhaust ports. The best method to obtain the clearance, filling with a measured quantity of water, proved unsuccessful.

The cylinder head was again removed, and the height of the center of the cylinder above the engine base was determined. The center of the indicator connection was at the exact center of the cylinder, and the shape and size of the steam port and the exhaust port were identical. This condition will be found on most Corliss engines. The cylinder head was replaced. A measured quantity of water was poured into the indicator connection until its level was at the exact center of the cylinder. As the steam and exhaust ports were of the same size, the volume of water added was one-half of the clearance volume. We repeated this several times. Crank-end clearance volume was determined in the same way.

Oklahoma City, Okla. MERL D. CREECH.

289. Failure of Large Pumping Engine.

The unit was a 22,000,000-gal., triple-expansion, vertical Corliss engine of the waterworks type. It was built about 1905 and has run practically continuously since. Recently it smashed up because the piston rod broke at the crosshead and allowed the piston to drive out the top head of the intermediate cylinder.

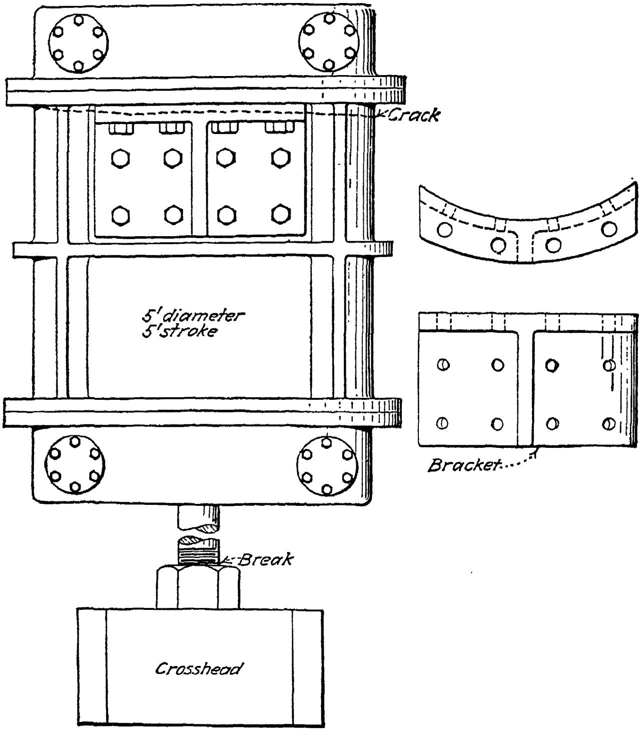


FIG. 96.—Special brackets to repair cylinder.

The engine had a 5-ft. stroke, and the immediate cylinder was 5 ft. in diameter. The valves were in the head, and when the rod let go it drove the top flange of the head up and cracked the head both at the flange and across the valve ports.

To repair it we are casting brackets, as shown in Fig. 96, to fasten on the side of the cylinder, and we intend to pull the crack together after filling it with a cement.

Rosedale, L. I. JOSEPH O'BRIEN.

290. A Stitch in Time Saves an Engine.

A lubrication engineer placed his hand on a large four-cycle engine and noted that it was excessively hot. He asked the reason. The only explanation was that something was "wrong with the oil." He took a sample from the crankcase in for analysis. The oil contained 28 per cent fuel oil. He at once telephoned the chief, told him of the report, and recommended replacing the oil in the case. The operator then looked for the fuel-line leak. This engine has the camshaft on the side of the cylinders, about level with the heads. All shaft bearings and cams are oiled from the engine's oil-circulating pump, and oil drippings are caught in a trough below the camshaft. A small fuel line in the bottom of this trough was found to be cracked at a coupling, allowing fuel oil to drip into the trough and return to the crankcase with the lubricating oil.

Walthill, Neb. W. W. DINGWALL.

291. Change in Oil Feed Stopped Bearing Heating.

Although provided with sight-feed cups in addition to the pressure line, end crankshaft bearings of a six-cylinder vertical engine ran hot and required taking up twice as often as those between cylinders. Oil from the lubricator was fed through sight feed, dropped through the ½-in. pipe, on to the top of the revolving shaft. Fully three-quarters of the lubricant fed either spattered or was thrown off the shaft without ever reaching the bearing.

At times, the oil feed would stop entirely because the air carried around the shaft built up a pressure at the lower end of the guide tube. The oil would eventually start to flow with a gush but with little or no relief to the overheated bearing.

By removing the feed pipe and substituting for it a brass plug *P* (Fig. 97) drilled out and having sweated into it a length of ¼-in. copper tubing, the trouble was eliminated. Tube *R* was curved to bring the oil flow nearly tangential to the shaft surface in the direction of rotation. When so installed, it was found that the slight suction set up at the orifice insured a steady flow of lubricant with a finer adjustment. The tube end just cleared the shaft. All the lubricant reached the shaft and cured overheating.

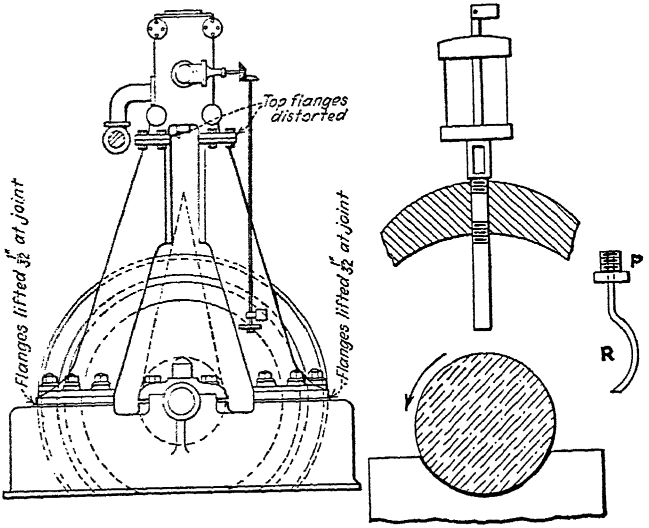


FIG. 97.—Oil feed changes to stop bearing heating.

Longview, Tex. ELTON STERRETT.

292. Removing Oil from Process Steam.

Much of the oil used for cylinder lubrication is carried away in the exhaust, and if an excessive quantity is supplied, the steam may be rendered very greasy. In a recent instance, the exhaust from a reciprocating engine was being used in the washing machines in a laundry, and, owing to the presence of oil in the steam, the clothes were occasionally stained. A compounded cylinder oil was being used.

An oil separator failed to remove all the compounded oil, because it existed as an emulsion in the steam, and oil in emulsion is difficult to remove. A high-grade straight-mineral oil was used instead, fed in the smallest possible amount, through a mechanical lubricator. No further complaints were received from the laundry.

Brentford, England. W. E. WARNER.

292A. A Separating Tank to Keep Oil out of Traps.

Figure 98 shows a closed tank used as a receiver and separator for returns and drips containing oil to keep the oil from passing through the trap. Returns enter the tank at the top, and the oil rises to the surface of the water. No water enters the trap until its level is above the horizontal section of the trap intake. All water passing through the trap is taken from the tank bottom. To drain the oil from the tank, the inlet is closed, and the vent and drain valves opened.

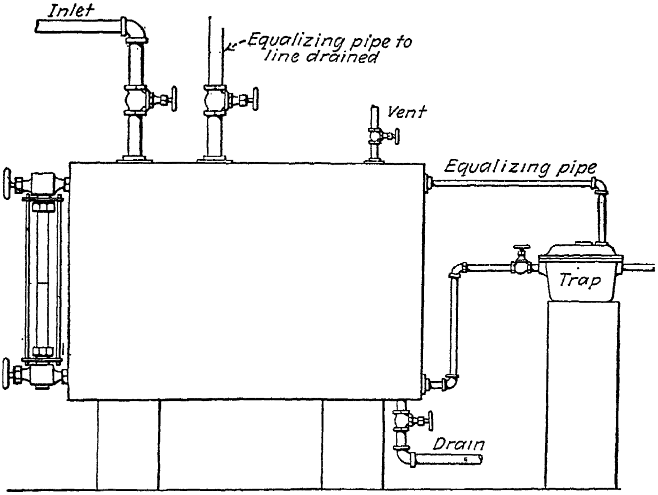


FIG. 98.—Closed tank used as receiver and separator for drips.

Matawan, N. J. G. B. LONGSTREET.

293. An Improvised Oil Strainer.

The improvised strainer in Fig. 99 was attached to the inflowing oil line on the base of a high-speed vertical steam engine, oil level being maintained by an overflow at the proper height on the opposite side of the base. The strainer was made large enough to avoid frequent removals for cleaning. With a hack saw, three apertures were cut in a piece of pipe about 15 in. long, and the edges smoothed with a file. Forty-mesh copper screening, 1 in. wider than the openings and ¾ in. longer than the circumference, was wrapped around a piece of wood whose diameter was equal to that of the pipe. This allowed a ⅜-in. lap, which was soldered. Then the copper cylinder was slipped off the wood and on to the pipe and clamped in place. A pipe cap on the bottom and the section of pipe between it and the screen served to catch any dirt that might be in the oil.

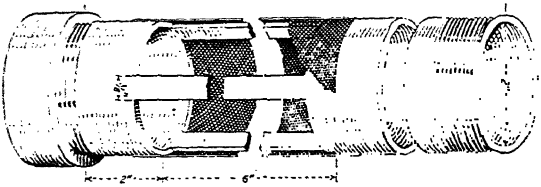


FIG. 99.—Detail of strainer.

Kingston, Ont. T. J. DONNELLY.

294. Cylinder Drains Damage Engine.

Here is a peculiar cause of water in the high-pressure cylinder of a steam engine. Drain pipes from the cylinders ran outside the engine room and discharged over a pond. In normal times, the pipes were well above the water, but a flood raised the level, and the ends of the drain pipes were submerged. The stop valve was closed to stop the engine, and, before the latter came to rest, the drain cocks were opened.

Owing to the vacuum in the cylinder, a vacuum was created in the drain pipe, and water was drawn up into the cylinder, seriously damaging both cylinder and rod.

Brentford, England, W. L. WARNER.

295. Inexpensive Flywheel Cleaner.

Our hospital power plant had just received a new coat of paint in the engine room and new terra cotta tiling on the floor. The engine room contains three Corliss engine-driven generators running at 200 r.p.m. After a few days, the walls and floors in line with engine flywheels were being spotted with oil. Oil on the floor made the tiling extremely slippery.

To overcome this, a cleaner was placed on the flywheels to keep them free from oil. It was simple, inexpensive, and hardly noticeable (Fig. 100).

Two pieces of spring steel were fastened to the floor at the edge of the flywheel wells by expansion bolts and shields. These were placed so that they were an inch clear of the rim of the wheel. Eyes were forged on the end of the springs to take ½-in. bolts. A long rod was passed through the two eyes with nuts at each end arranged to clamp the rod to the springs, serving to keep the spring and rod rigid. When in position the rod pressed tightly against the face of the flywheel.

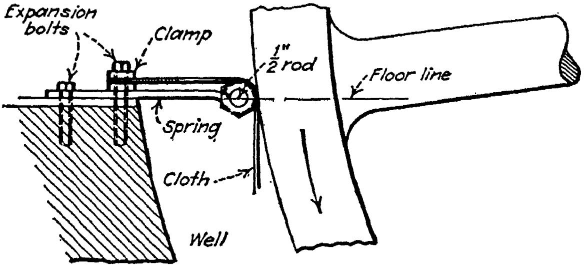


Fig. 100.—Section showing construction of flywheel cleaner.

A piece of thick absorbent cloth about ½ in. wider than the face of the flywheel was clamped between two pieces of ⅛- by 1-in. flat iron by bolts placed at 2-in. intervals along the clamp. The ends of the clamp were drilled so that it could be attached to the springs by means of the expansion bolts. The cloth was then hung over the rod between it and the flywheel. The springs kept it pressing against the face of the wheel yet allowed it to give way to any irregularity. This kept the wheel free of oil and at the same time polished the surface. The cloth is easily removed as required.

Irvington, N. Y. Charles R. Know.

296. Lubricating High-temperature Cylinders.

We have no trouble lubricating high-speed passenger engines with a short cut-off (25 to 30 per cent) at 730°F. with a 560-flash valve or cylinder oil. I should say that about 750° is the limit with a 25 per cent cut-off and about 680° with a late (75 per cent) cut-off, for satisfactory lubrication with a good average quality of cylinder oil.

New York, N. Y. W. P. Lambert,
Engineer, Sales Department,
Standard Oil Co. of New Jersey.

297. Trapping Leakage through Cylinder Stuffing Box.

An engineer in charge of a high-speed engine of the splash-oiled type found it difficult to keep the piston rod from carrying water of condensation from the cylinder into the guide barrel, whence it flowed into the crankpit. The result was a churning of the oil and water into a thick emulsion.

The engineer spread a sheet-iron diaphragm across the crankcase between the guide barrel and crankpit and arranged to draw the oil and water from the guide barrel into a separator, from which the oil returned to the crankpit and the water flowed away to the sewer.

The diaphragm was made tight at the edges, and a slot cut in it just large enough to give the connecting rod free action. The drain pipe leading from the guide barrel was tapped in just ahead of a rib that had been cast integrally with the frame to form a partition between the guide barrel and stuffing-box housing. Separate drainage of any water dripping directly from the stuffing box was thus possible.

St. Louis, Mo. D. J. Allison.

298. What the Indicator Showed.

Figure 101 was taken from a low-pressure 64- by 48-in. vertical cylinder of a rolling-mill engine running at 110 r.p.m. and developing 2,500 to 2,800 hp. The low-pressure reciprocating parts weigh about 14,000 lb., the connecting rod is 11 ft. long, and the inertia force is about five times the weight.

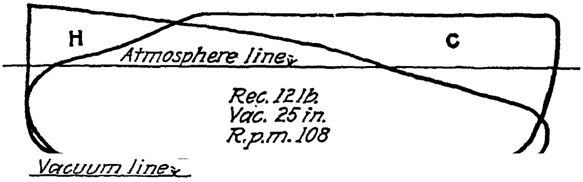


Fig. 101.—Diagram before valves were set.

The diagram shows steam distribution when I was called in: poor compression, late cut-off, and consequently low receiver pressure. Not only did the engine pound badly and run hot on the crankpin, but the bronze boxes of the crosshead-pin end of the connecting rod were continually being scored and ground out. Load was poorly distributed between the high- and low-pressure cylinders, the engineer being afraid to put load on the low-pressure cylinder by shortening the cut-off, which was adjustable by hand.

The diagram (Fig. 102) shows steam distribution after resetting valves. The low-pressure engine has double wrist plates with separate eccentric for each. The change consisted chiefly in advancing the low-pressure exhaust eccentric 4 in. around the shaft and adjusting cut-off to maintain a receiver pressure that would divide the load between the high- and low-pressure cylinders.

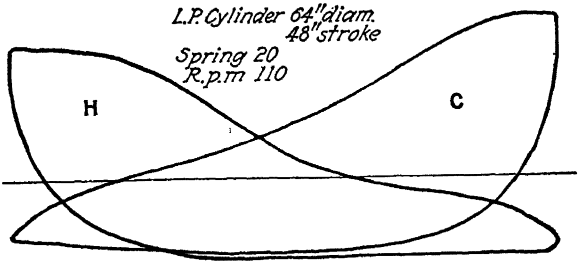


FIG. 102.—Diagram after setting, showing better steam distribution.

Lakewood, Ohio. D. P. FOLTON.

299. Connection to Indicator Motion.

The cord connection to the reducing motion is tied to a small coil spring or elastic cable (Fig. 103). The spring is fastened to any rigid support. On the cord is a small button of aluminum or hardwood. This button has a setscrew with a small pin under it for clamping the button in an adjusted position so that the reciprocating motion of the button is within the limits of motion of the cord to the indicator barrel. After the button has been adjusted for position, the indicator can readily be connected to the motion by drawing the indicator cord hook out to full length and releasing it ahead of the button. There is little danger of the indicator's being jerked out of line or having an incomplete stroke, since the limits of motion of the cord to the indicator barrel may be readily compared with the extreme position of the button before the hook is placed over the button.

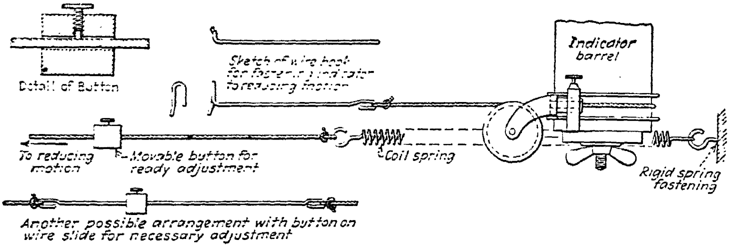

Detail of Button
Sketch of wire hook for fastening indicator to reducing motion
Indicator barrel
To reducing motion
Movable button for ready adjustment
Coil spring
Rigid spring fastening
Another possible arrangement with button on wire slide for necessary adjustment

FIG. 103.—Method of connecting indicator to reducing motion.

The cord to the reducing motion is constantly under a higher tension, so there is less tendency for sag or whip in the line. It is well adapted, for this reason, to higher speeds.

Norman, Okla. H. V. BECK,
Assistant Professor, School of Mechanical Engineering, University of Oklahoma.

300. Simplifying Taking of Diagrams.

The cord in this device is attached permanently to the reducing motion and indicator drum, while the drum is prevented from rotating by adjustment of the spring clip as shown in Fig. 104. Figure 104-1 shows the device open; Fig. 104-2 shows it closed. *A* is a steel spring member; *B*, a sliding collar; *C*, the cord leading

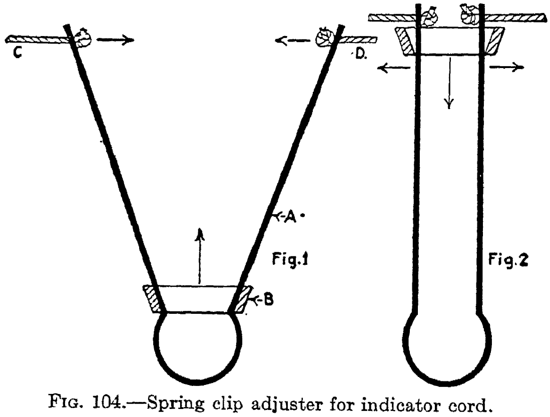


FIG. 104.—Spring clip adjuster for indicator cord.

to the indicator drum; and *D*, the cord leading to the crosshead by way of the reducing motion or gear.

London, England. J. T. Towlson.

301. Simplifying Taking of Indicator Diagrams.

Experience shows that any but the lightest form of clip or hook interferes with smooth working of the cord, affecting the shape of the diagram. Cord attachment must be strong, light, and easily adjustable (Fig. 105). The simple hook, when properly shaped and in capable hands, performs all necessary operations successfully. Care must be taken when bending the hook to shape that the bottom is in the form of a groove similar to that used in the sheave of a rope drive, and when in actual use the cord should set lightly in the bottom of the groove. Such a hook provides easy manipulation, smooth running, cord secured without knots or loops, slips when excessively loaded, adjustability in use for any size of cords.

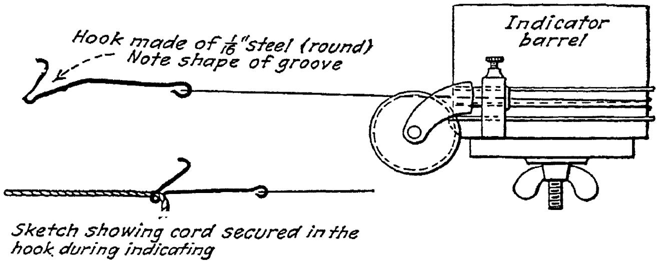

Indicator barrel
Hook made of $\frac{1}{16}$" steel (round)
Note shape of groove
Sketch showing cord secured in the hook during indicating

Fig. 105.—Type of hook permitting ready adjustment.

Blackburn, England. J. Cassidy.

302. Homemade Metal Packing.

We had considerable trouble keeping the 6-in. piston rods and the valve stems properly packed on six 22- by 30-in., slide-valve engines which used superheated steam at 165 lb. gage. Several brands of packing had been tried out, none entirely satisfactory.

Saturday nights, when the load was heavy for a longer period of time, it was common to have one or two piston rods and at least one valve stem blow out. Metal packing was tried in place of the rubber-inserted and fabricated packing in use. The packing was made at the plant from designs submitted by one engineer (Fig. 106). These rings were made of good-grade babbitt metal. Rings for the pistons and valve stems were of the same shape, that is, three-cornered rings made so that when two rings of either four or six sections were placed together, it would make one square ring in cross section.

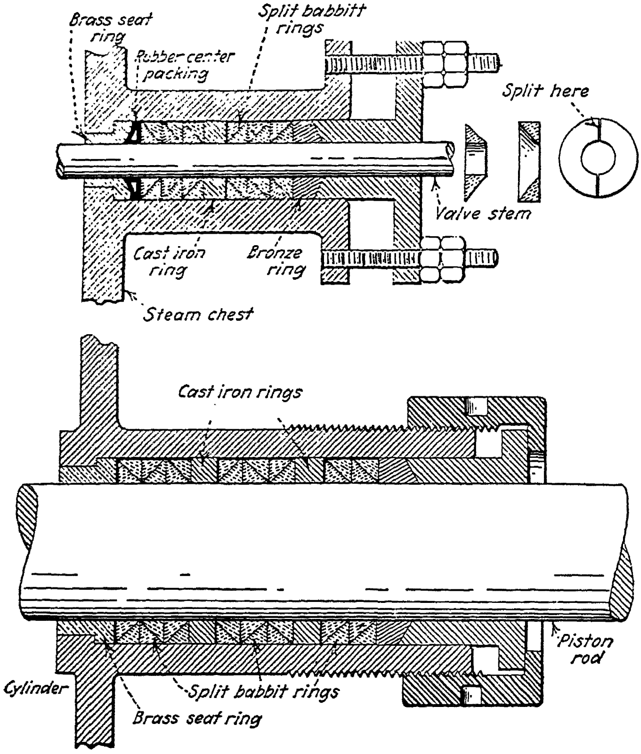


FIG. 106.—Metal packing made of split babbitt rings.

Three complete rings were placed after the brass seat ring on the piston rods, and then a split ring of cast iron of the same thickness, then three more complete babbitt rings, another cast-iron ring, two more babbitt rings, and a thrust ring next to the gland, also of cast iron.

The gland was screwed up tight with the spanner, backed off loose, then screwed back finger tight. A glass, quart-size, sight-feed oiler was placed above the piston rods, using half cylinder and half light engine oil to lubricate the packing and rods.

At first, the packing leaked more or less on account of being too cold, but after the engine had been in operation a few minutes under a full throttle, the packing expanded and tightened up, and only a small amount of adjustment was necessary. In no case did packing score the rod. Valve stems were fitted in exactly the same manner, only in this case six complete babbitt rings were used, and one cast-iron and one bronze ring, the bronze ring taking the gland.

A little more adjustment was necessary on these rods to make the packing tight. The two-section split babbitt rings proved better on the smaller rod than the three section rings. The hotter the rings got the better they held, and only on the occasion of a periodic shutdown of the superheaters did they leak.

After four years, it is now planned to renew the packing rings on the piston rods and the valve stems on one unit and test them for crystallization and wear. On one engine, a rubber-center asbestos high-pressure ring will be used on the valve stems only, after the brass seat, to insure a good joint on account of the high temperature at this point.

Auburn, N. Y. W. L. JOHNSTON.

303-309. Seven Tips on Fitting Old Pistons with New Packing Rings.

303. When the cylinders of reciprocating engines, steam pumps, and air compressors have become scored and worn unevenly to the extent of needing reboring, a perfect job often requires that the old pistons be discarded and new ones adapted to the enlarged bore. Otherwise, the pistons may have so much play that the packing rings cannot keep them tight.

304. The wobbling tendency of a piston too small for the bore is much greater in vertical than in horizontal cylinders.

305. Another requisite is that the rebored cylinder be given extra lubrication until the minute ridges left by the boring tool have been worn down. Neglect of this precaution may result in such damage to the cylinder wall and packing rings as to undo the benefit the reboring was intended to secure.

306. Where reboring has not increased the diameter of the cylinder to the extent of necessitating a larger piston, it nevertheless is necessary in all cases to furnish the old piston with a new set of packing rings. It is not always good economy to apply for a new set of rings to the factory where the machine was built. Because of wear in the grooves of the old piston, rings thus secured may fit so loosely as to be practically useless. Usually, the proper thing to do is to send the piston to the nearest repair shop equipped for such work.

307. It is necessary to put the piston and its rod between the centers of a lathe and true up the grooves. After this, the rings may be made. A perfect job demands that the cylindrical blank from which the ring is cut shall be given an outside diameter considerably larger than the engine bore and an inside diameter somewhat smaller than that of the finished ring. Then, after a short segment has been sawed out of the ring, the opening thus made should be closed by springing the sawed ends together, the outside of the ring turned off to the exact diameter of the cylinder, and the inside bored out to give the requisite thickness. Also, the sides of the ring should be faced off to a sliding fit in the grooves of the piston.

308. The inside and outside circles of snap rings for pistons of small and medium size should be turned eccentric to each other. A packing ring so formed will bear against the cylinder wall with an even pressure at all points in its circumference. But if this type of packing ring has been finished without first cutting a segment out of the thinnest section, springing the ends together, and then turning off the periphery to fit the cylinder, its liability to leak will be greater than that of a truly concentric ring.

309. An excellent form of snap-ring packing for small and medium-sized horizontal engines was used on straight-line engines designed by Prof. John E. Sweet. A cast-iron arc-shaped segment, turned off to the radius of the cylinder, is set stationary in the lower part of the piston groove. This segment is just deep enough in its vertical dimension to block the piston up exactly central, and the ends of the eccentrically turned packing ring, abutted against the level surfaces of its lateral extensions, make steamtight joints therewith. The necessary tension is given the ring, before snapping it on the piston, by springing the ends inward and turning off the periphery to the exact cylinder diameter. Packing rings so made have been found steamtight after 10 years of service.

St. Louis, Mo. A. J. DIXON.

310. Stopping Building Vibrations Due to Unbalanced Engines.

Several years ago, I had charge of the construction of a large power plant, which, when completed, swayed on its foundation so violently that provision had to be made to stop the motion to prevent serious damage to the building.

On account of the unsubstantial nature of the soil on which the plant was built, the plans provided that everything should be supported on piles. The engine bed was intended to be independent of the rest of the building, and the piles that supported it were driven on 2½-ft. centers each way. These piles were cut off at about the level of the marsh, and a bed of concrete, extending down over the top of them about 1 ft., was installed to a height of about 8 ft. On top of this bed of concrete the engine foundations were built of red brick laid up in portland cement to a height of 12 ft.

The engines were cross-compound horizontal condensing units and were each of about 1,800 hp. (nominal) and designed to run at 80 r.p.m. The flywheels were 24 ft. in diameter, built up in segments with boiler plates riveted on each, the complete wheel weighing over 125,000 lb. The 1,200-kw. generators were direct connected, the armature being built on the engine shaft.

When the first engine, which was on one end of the building, was started up, and the speed brought up to around 72 r.p.m., the entire building began to rock back and forth. The engine was immediately slowed down, and even then the motion could be noticed to a slight extent. At first, it was not thought that the vibration would cause any trouble. The next day, the engine was slowed to around 68 r.p.m., which seemed to steady the building somewhat, although it would rock occasionally. The engine was run that way for about two weeks until engine 2 was ready to put on the line. When the two engines were tried together, the trouble became serious. The entire building swayed violently; the motion would come up to a maximum, die away gradually, and then increase again at about 2-min. intervals.

We decided to counterbalance the reciprocating parts of the engine similarly to a locomotive and thus stop the trouble. Three weights, each of about 200 lb., were made and bolted on the spokes of the flywheel about opposite the low-pressure crank or in line with the low-pressure counterweight cast in the crank disk.

The low-pressure crank was about 90 deg. after the high-pressure crank. These counterweights seemed to help slightly but not enough (Fig. 107).

Larger counterweights, part of them weighing about 590 lb. each and part about 530 lb., were made in two parts, so that they could be bolted around the spokes near the rim of the flywheel. As soon as these were received, they were installed on engine 1, about 1,600 lb. being put opposite the low-pressure crank and about 1,200 lb. opposite the high-pressure crank.

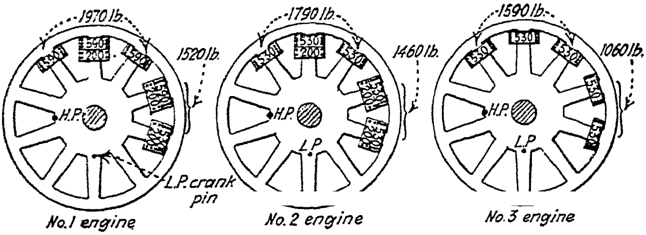


Fig. 107.—Location of weights on engine flywheels.

The flywheel of the three engines were finally loaded as follows: No. 1, 1,970 lb. opposite low-pressure crank, 1,520 opposite high crank pressure; No. 2, 1,790 lb. opposite low-pressure crank, 1,460 opposite high crank pressure; No. 3, 1,590 lb. opposite low-pressure crank, 1,060 opposite high crank pressure.

Motion of the building with the three engines running was only about $1/32$ in. in about 2-min. intervals, and even this was reduced after the entire marsh was filled up to the level of the basement floor and the filling became settled into place. These weights remained on the engines for several years.

Plainfield, N. J. Charles H. Bigelow.

311-317. Seven Failures of Valve-chest Covers and How to Avoid Them.

A recent failure of a large steam-engine valve-chest cover calls attention to a danger in connection with compound steam engines —that of high-pressure steam passing into the low-pressure cylinder or into the receiver or pipes between the cylinders. The valve chest of the high-pressure cylinder of a compound engine is designed to stand the boiler pressure, but the chest of the low-pressure cylinder is usually designed for a much lower pressure, around 35 to 40 per cent of the boiler pressure.

There are several ways in which excessive pressure may be produced in the low-pressure valve chest.

311. It is possible for the danger to arise when the engine is being warmed up prior to starting. If, for example, both the ports of the low-pressure cylinder should be closed when the engine is being warmed up by high-pressure steam, pressure may gradually accumulate in the valve chest to a dangerous extent. This happened at a textile mill, and as a result a large cover 8 ft. long by 4 ft. wide was blown from the valve chest of the low-pressure cylinders.

312. Excessive pressure may be induced in the low-pressure valve chest by failure of the high-pressure cylinder steam-admission valves to close when the engine is at work. Should this happen, high-pressure steam will pass into the first cylinder continuously, and if the exhaust valves operate normally, high-pressure steam will pass through to the low-pressure valve chest.

313. Failure of a high-pressure admission valve to close is usually caused through some fault in the dashpot. Excessive pressure in the low-pressure valve chest may also be brought about through the low-pressure cylinder admission valve's failure to open; steam rapidly accumulates in the chest, and the pressure quickly rises to a dangerous extent. A low-pressure admission valve may fail to open through the valve lever's breaking or because the key used for securing the lever to the valve spindle works loose and falls out of position.

314. Many cases of overpressure and consequent failure of low-pressure valve chests have been the result of increasing the working pressure with the object of increasing the power of the engine. The fact should not be lost sight of that an engine is designed, in the first place, for a certain initial pressure, and, if a higher pressure be adopted, the parts may be stressed to an unsafe amount unless they are suitably strengthened.

315. It is essential that suitable provision be made to guard against the danger of explosion. The safest plan would, of course, be to design the receiver and the low-pressure valve chest and cylinder for the full boiler pressure, but this means greatly increased cost of construction.

316. As a safeguard against overpressure, the receiver or the pipes between the cylinders should be fitted with a safety valve of ample area. Too often, this valve is too small for its purpose, being incapable of relieving a sudden large increase in the volume of the steam. If a valve of large area is fitted, and maintained in good working order, the possibility of explosion from an overpressure will be slight.

317. The foregoing remarks have been confined to the compound or two-cylinder engine but are applicable to three- and four-cylinder engines. Here is failure of a triple-expansion engine fitted with Corliss valves. The engine was running at its usual speed and under normal working conditions as regards boiler pressure, vacuum, etc., when the failure occurred. Without warning, a large portion of the intermediate-cylinder valve chest cover was blown out with great violence. The low-pressure valve-chest cover was also fractured. The explosion was caused by excessive pressure in the intermediate valve chest, but how this excessive pressure was brought about cannot be explained with certainty. It is stated to have been due to one of the high-pressure admission valves' failure to close or to the steam valves of the low-pressure cylinder becoming inoperative and remaining in the shut position. A safety valve was fitted to the intermediate valve-chest cover, but it seems doubtful if this valve functioned at all.

Manchester, England. EDWARD INGRAM.

318. Turbine vs. Engine for Noncondensing Operation.

Two different conditions must be assumed, and the decision given for each. Consider operation at 200 lb. gage, 100°F. superheat, and a 500-kw. unit running noncondensing.

As the first case, assume that all exhaust steam, regardless of the steam rate of the prime mover, can be utilized in manufacturing. In the second case, assume that the total steam demand and fuel consumption are determined mainly by the efficiency of the prime mover.

For the engineer doubtful of lubrication at steam temperatures of 500°, it may be stated that reciprocating engines are being lubricated satisfactorily at temperatures around 800°. To avoid trouble with oil in the engine exhaust where such steam is used in process, provisions for removing this oil from the steam should be considered, or an engine unit be selected that requires no internal lubrication. Engines using steam at 350 lb. pressure are operating successfully without internal lubrication. An engine unit will take up more space than a turbine, but with some types of engine the difference is not great.

Referring to the second assumption: If the larger boiler room and greater storage space for fuel and ashes of the turbine plant are considered, the net advantage in space may be reduced to zero or in favor of the engine.

Engineers do not agree as to the comparative steam rates of the two types of prime mover. This difference may be due to the different classes of units that they have in mind. For instance, it would be possible to select a high-class turbine having a lower steam rate than a low-class engine. For units of comparative class, there is, without any chance for argument, a decided difference in favor of the engine unit. Under average working-load conditions, with the steam range and unit capacity given, steam consumption of the engine generally will be found to be around 15 to 20 per cent less.

As to comparative costs, the engine unit will cost more than the turbine. In referring to the second case, the cost of the boiler room will be dependent upon the steam demand, which for the engine is 15 to 20 per cent less. The difference in boiler-room costs will be much more than the difference in prime-mover costs, so that the complete engine plant will cost less than the complete turbine plant.

In the first case the advantages of one unit just about balance the advantages of the other unit, so that a decision in prime movers may be a matter of opinion.

In the second case, with the advantages in plant costs and total space occupied reversed in favor of the engine plant, longer life of unit, better overload and underload operations, together with a 15 to 20 per cent lower fuel consumption, the decision of an engineer or businessman will be with the high-class engine unit.

Chicago, Ill. JOHN F. FERGUSON.

CHAPTER V

TURBINES AND CONDENSERS

319. Causes of Turbine Vibration.

A turbine generator developed vibration, finally traced to spindle warping. High-pressure steam leaked from the dummies through four holes around the spindle, causing uneven heating of the spindle and producing distortion. The holes were plugged; this stopped vibration.

In another instance, the vibration was traced to wear of coupling gear teeth. Vibration occurred only when the gears were in mesh. A new set of gears cured this trouble.

A defective high-pressure shaft seal allowed steam to leak between the shaft and the rotating part of the seal mounted on it. This caused unequal heating of the turbine shaft, which, in turn, caused the rotor to vibrate. Before the fault was corrected, the seal rubbed and was damaged to such an extent that it had to be renewed. To prevent a repetition, grooves were cut on the inner circumference of the new seal member so that in the event of steam's leaking it would be distributed around the shaft, and no uneven heating could occur to distort the shaft and cause vibration.

Wear of the claw coupling between turbine and generator allows it to become radially displaced and causes vibration. In one instance, the flexible coupling showed signs of hammering. Clearance between the faces had increased considerably and had developed shoulders nearly 1/16 in. high. After the shoulders were removed and the coupling adjusted, the unit ran without vibration.

The only way to eliminate vibration is to remove the cause, but where it persists and no fault can be found, running of the machine can often be improved by filling the bed plate with concrete and grouting it down solidly. Reducing the clearance of the shaft in its bearings to a minimum consistent with cool running is also effective, the usual running clearances being 0.001 in. for each inch of shaft diameter.

Another trouble that may occur is distortion of the turbine casing through expansion and contraction of connected steam and exhaust piping. This makes expansion joints or expansion bends necessary in the pipe. When expansion joints are used, they must be properly packed and must have sufficient capacity.

In one instance, the labyrinth packing at the low-pressure end of a large turbine failed through distortion of the rigid piping connecting the turbine to the condenser. After this mishap, the rigid piping was replaced by a flexible connection, and there was no further trouble. In another instance, the labyrinth packing at the high-pressure end of a turbine failed, owing to the pull on the casing caused by rigid bracing of a steam pipe.

Rapid temperature changes within the turbine must be avoided. A set should be started up slowly, so that the turbine will heat up evenly, and excessive stresses will be avoided. Not infrequently, when a turbine is being started, a slight vibration is noticed, which lessens as the turbine warms up. This is generally due to distortion, causing the diaphragm, glands, or other parts to touch the rotor spindle slightly. Provided the set is warmed up slowly, this initial vibration will do no harm.

Brentford, England. W. E. WARNER.

320. Turbine Shaft Packing.

Turbine shaft packing should be fitted so that it has a clearance of 0.001 to 0.002 in. per inch of shaft diameter with the machine cold. Metallic packing does not require so much clearance as carbon, since expansion is much greater under high temperature.

321. Odd Break and Quick Repair.

Toward peak period, while load was being distributed on several machines, it was noticed that for some reason one turbine would not take its load. We found that the last valve was not lifting, although we could not see where the stem was broken.

When load had lightened sufficiently, the turbine was shut down, and the valve taken out. The stem was found broken at the threaded part at the bottom of the nut, as shown at left in Fig. 108. As no spares were on hand, the valve-stem guide plate was chucked in the lathe and recessed as shown. The thread on the valve stem was run down with a hand die. The reassembly is shown at the right. There was less chance of a break at this point after repair than in the original, so what was at first intended for a temporary repair became a permanent one.

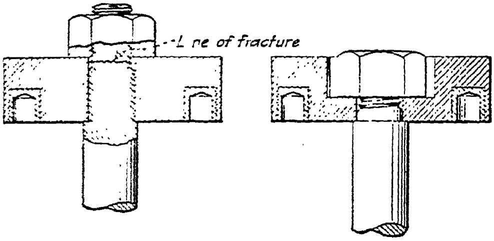


FIG. 108.—How valve stem was repaired quickly.

Chicago, Ill. S. M. QUINN.

322. Regulator Valve Diaphragms.

Rubber-composition diaphragms on diaphragm-operated, spring-loaded, or weight-loaded regulating valves are short-lived on oil service. The side exposed to oil generally deteriorates rapidly.

After several replacements of diaphragms during a few months, I decided to protect the diaphragm while retaining sensitiveness.

A hardwood block 12 in. square and 2 in. thick was affixed to the face plate of a lathe. On this face I drew a circle about 8 in. in diameter, the same size as the regulator diaphragm. Six concentric circles were then drawn starting at 2 in. in diameter. Shallow V-shaped grooves were turned in the face of the block at the circles, each about 1/16 in. deep and about 3/16 in. wide.

A piece of brass shim plate about 10 in. square was then fastened to the face of the block, and V indentations were spun into the shim surface until the six V depressions were formed into a bellows surface. This plate was then cut to 8-in. diameter and installed on the oil side of the diaphragm, thus protecting the rubber from the oil.

Chicago, Ill. H. J. PRIBENSEN.

323-326. Four Changes in Operating Methods Prevent Turbine Overspeed.

Abnormal operating conditions may arise that take a turbine's speed control out of range of the service governor and cause the emergency overspeed trip to function. Heading the list of abnormal conditions is sudden and entire loss of load, as when circuit breakers open on the generator bus or breakers on all of the outgoing lines trip out. When these disturbances can be anticipated, turbine speed can usually be controlled within normal range by changes of operating methods. With generating stations, approaching electrical storms often give reason for expecting such trouble.

323. It has been found advisable in many cases to close down the throttle valve to the turbine until a slight reduction in nozzle pressure is indicated on the gage. By doing this, any sudden increase in throttle flow is partially restricted. Should the overspeed trip operate, time required to close the throttle valve for resetting the overspeed trip is reduced.

324. In some plants, located where severe storms are common, boiler pressure is reduced as much as 40 per cent during a storm. Reduced pressure causes the turbine to accelerate less rapidly on sudden load reduction than at full steam pressure.

325. With compound machines, the low-pressure unit has greater capacity than the high-pressure. With these, procedure is similar to that followed for single-cylinder units, but, in addition, the valve controlling steam flow to the low-pressure cylinder is throttled to cause a slight pressure reduction to the first stage. In one plant, this reduction is held at 10 per cent.

326. Throttling of the intercepting valve between the high- and low-pressure turbines also assures quick closing of this valve. With high-pressure units, allowing this valve to remain open too far will cause the storage capacity of the steam mains and reheat system to supply sufficient steam to overspeed the turbine even after the high-pressure governor has responded.

Cleveland, Ohio. M. E. Wagner.

327-330. Four Pointers on Dismantling Governors.

327. It is frequently necessary to look over the thrust bearing and governor-drive gear. To raise the governor out completely, it is necessary to remove the holding-down bolts and disconnect the pilot valve (after tramming or marking the setting) and governor arm at the steam valve and the governor.

328. The Jahns or a similar type is generally topheavy and has to be raised from 6 to 7 ft. to clear the pedestal. Tying ropes around the governor to raise it is decidedly dangerous.

Here is a lifting gear: In four pieces of iron about 24 in. long, 2 in. wide, and ½ in. thick and four pieces the same length and width about ⅜ thick, drill ⅝-in. holes at each end and the same distance center to center for the holding bolts. The bolts should be long enough to go through the four iron straps when in place on the governor. When the lifter is in position, place a sling or rope around the corner of it, making one knot and leaving the sling free to slip around the hook on the hoist (Fig. 109).

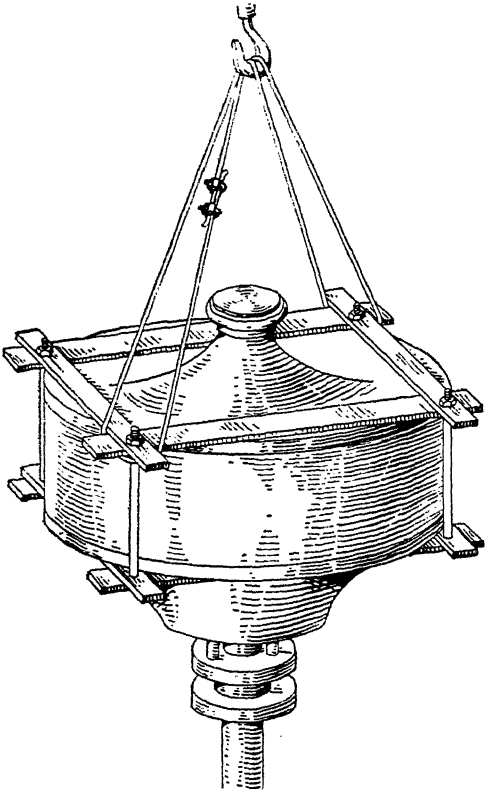


FIG. 109.—Lifting gear for turbine governor.

329. In lifting one man should guide the governor spindle until it is free from the turbine and at the same time see that the bearings are not damaged.

330. Before lifting, mark the governor pedestal, noting the position of the slot at the end of the governor spindle. This will insure accuracy of position in relation to the gears and pump when the governor is again lowered into place.

New Haven, Conn. PHILIP T. HYNES.

331. Ship's Turbine Carried Only Half Load.

A government ship-repair award to a certain yard included repair of a steam-turbine-driven generating unit for light and power for a large winch.

The turbine was finished and run, apparently functioning all right, but it would furnish only half load.

This was only two days before the time limit; there was no time to lose. The service men had taken the covers off everything and reported all in order—only the turbine would not work.

With the turbine designer down to the ship, we started up the turbine—and got the same result. After a little inquiry and thought, he asked that the governor casing be removed so he could examine the mechanism. He did so. After going over it, he told us we had the piston valve in *upside down.* When this was changed, the set was run up again to speed, and it carried full load and even 25 per cent overload with no sign of trouble.

This experience indicates very clearly the need for care in marking parts of this kind when they are first removed from the turbine, particularly so where the part is symmetrical and will fit in either a right or a wrong position. Marks to indicate the right position of a part, such as a governor valve, are seldom, if ever, made by the manufacturer so must be taken care of by the purchaser.

Meriden, Conn. J. S. ISDALE.

332. Jointing Material for Diaphragms.

Here is a suitable diaphragm-jointing material for steam turbines operating at pressures of 175 to 350 lb.: A mixture of cast-iron filings and manganesite putty worked to a fair consistency will make a practically unbreakable joint and prevent any leakage of steam from the high- to the low-pressure stages.

Zamora, Mex. ROBERT H. NORTON,
Assistant Superintendent, Guanajuato Power and Electric Co.

333. Preventing High Exhaust Pressure in Turbine Casing.

Provision to prevent excessive pressure building up in the exhaust hood of a condensing turbine must be provided. On many large installations, a low-vacuum trip is provided. It should be supplemented with some other safety equipment in many cases.

In one installation, a heavy lead diaphragm was placed between the flange at the top of the exhaust hood and a companion steel ring on the top. If the trip failed to operate the governor, this diaphragm would blow out and at once place the condenser pressure at atmospheric. When this occurred it was a several hours' job to replace the diaphragm.

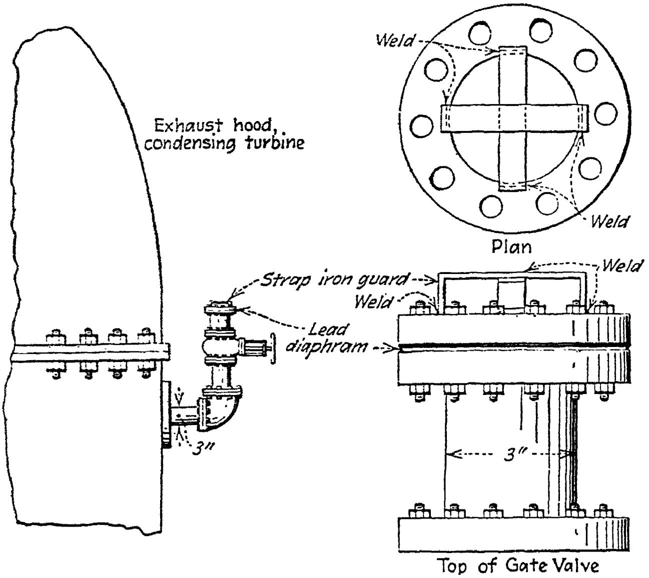


FIG. 110.—Detail of lead diaphragm-relief arrangement.

To avoid diaphragm's rupturing if possible a 3-in. line with gate valve was tapped into the manhole at the side of the exhaust hood. At the top of a short nipple, a flange, lead diaphragm, and steel ring were placed similar to the one at the top of the turbine. The lead in this small diaphragm was of much lighter gage than that in the larger one on the turbine, and it could be depended upon to blow out first in case of trouble.

As soon as the cause of the vacuum loss was corrected, the small gate valve could be closed, and the turbine started at once, the small diaphragm being replaced when convenient. A strap-iron guard was placed over the diaphragm as shown in Fig. 110.

Boston, Mass. HARRY M. SPRING.

334. Finding the Lost Half Inch of Vacuum.

Some time ago, I was called in to correct a low-vacuum condition on a steamer equipped with turbines.

The turbine expert had overhauled the turbine and gears and found everything perfect; but with the same steam pressure and number of nozzles open the speed of the propellor shaft was consistently 2 r.p.m. lower than on other similar steamers.

A mercury column on the condenser inlet indicated 28.5 in. of vacuum. A thermometer on the exhaust connection of the turbine indicated 100°F., which corresponded approximately with 28 in. vacuum.

Drawings of the condensers and exhaust line from the turbine were checked and found to be the same as for the other vessels. The pressure drop, however, was unusual.

Finally, the exhaust connection was removed, and we found that a deflecting baffle had been inserted in the steam inlet to the condenser. The free area for the inlet of the exhaust steam was thus restricted.

After removal of the baffle, operation of the turbine was perfect, the temperature of the exhaust decreased to 91°, corresponding to the vacuum in the condenser, and the revolutions of the propeller shaft increased to normal.

The strange part about it was that the baffle had not been shown or indicated on the original drawings of the condenser.

Brooklyn, N. Y. JOHN DOBSON.

335-338. Four Hints on Making Turbine Joints Tight.

We had considerable difficulty keeping the upper and lower halves of a multistage turbine tight, especially where the halves join at the ring casing on the high-pressure end.

335. First we tried a lead, copper, and asbestos gasket, with poor results. The packing must be just the right thickness. Too thick a packing on the nozzle ring and ring casing tends to keep the top and lower halves of the casing from butting; likewise, too thick a gasket between the upper and lower halves will give a space between the nozzle ring and upper half of the casing, with the result that steam will blow over the nozzle ring and greatly impair the efficiency of the turbine.

336. It is needless to try to make a turbine of this type tight at the horizontal body joint if the necessary precautions were not used throughout the entire assembly. Before lowering the turbine spindle into position, the lower casing should be smooth and freed from all burrs and dirt.

337. It is imperative that every little detail be taken care of before lowering the spindle into the turbine. The studs in the stationary diaphragms should be down in their respective grooves. Give the lower half of the casing a coating of graphite mixed with cylinder oil. Should the nozzle holes be out of line, they can readily be brought to their proper position by inserting a bar into the nozzle ring and forcing the ring to its place. The same precaution should be used when lowering the top half of the casing. By using a small lead wire for a gasket (about 10-amp. fuse wire) and taking up on the nuts gradually and evenly all around, a tight joint should be secured.

338. If the turbine casing is warped considerably, it will be difficult to make a permanently tight job, but by following the instructions outlined here one should be able to make a tight job. Assuming you have the top half of the casing off, make sure that the upper and lower halves are clean and free from dirt and go over the planed surfaces with a fine file. Set the top half of the casing on and pull it down with a few bolts to make sure it is down all around. (Generally, the warpage is found around the high-pressure side.) Take your feeler gage and insert the thickest leaf that you can and slide it around as far as you can; now make a mark on the lower casing to show where the feeler gage entered and stopped. Also mark the thickness of the leaf.

Proceed in like manner around the casing where it is warped. It is a good idea to try the feelers all around the casing, as in this way one can determine with a fair degree of accuracy the true condition, and it facilitates making a skillful job later. If you find the openings are quite large, you may have to use annealed sheet copper graduated to the varying thickness, as indicated by the feeler gage. However, this is necessary in extreme cases only.

When you take the top casing off again, you can cut copper of the different thicknesses and slip it over the studs where you have your marks. Now take a vulcanizing type of packing and cut it in strips of about ⅜ or ½ in. wide; lay it inside and outside the bolt circle, piecing it wherever you wish, as the packing vulcanizes when steam is applied to the machine.

New Haven, Conn. PHILIP T. HYNES.

339. Steam Stand-by Generating Set Operates Automatically.

The automatic control shown in Fig. 111 was developed for a hospital where electric service was essential at all times. A turbine-generator set was selected because boiler capacity was always available, and it was desired to operate the generator as a synchronous condenser at certain times for power factor and correction. Normal power supply is obtained at 115 to 230 volts for lighting and 550 volts for power.

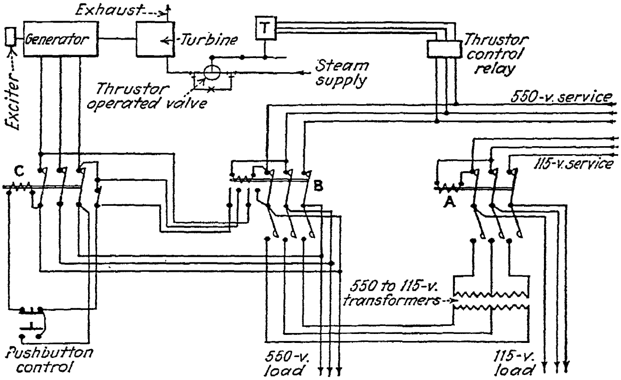


FIG. 111.—Automatic control for stand-by generating set.

On failure of normal service, the Thrustor-operated main valve admits steam to the turbine. Transfer switches *A* and *B* throw the load on the generator, but the generator contactor does not close until exciter voltage has built up and field is applied to the generator. The set then takes load, voltage being maintained by a simple regulator. When on the generator, the lighting is supplied from two distribution transformers, connected open delta.

On return of normal supply, the load is transferred, steam is cut off, and the generator runs as a condenser. Manual push-button control permits the condenser to be shut down or started at any time. On power failure, the manual control is shunted out by auxiliary contacts on the *B* transfer switch. The generator is provided with standard automatic starting control (not shown) and will automatically start up and take load if shut down at the time of power failure. The set must be shut down by the operator after normal service has been resumed.

The generator is a standard revolving-field type, equipped with an amortisseur winding. The turbine is a single-stage noncondensing type designed for quick starting and exhausts at 5-lb. back pressure. Exhaust is connected to an exhaust header to maintain heat in the turbine for quick starting. The dashpot action of the Thrustor-operated valve prevents the sudden application of full pressure to the turbine.

Montreal, Que. R. G. BARBOUR,
McDougall & Friedman,
Consulting Engineers.

340. Control of Cooling Steam to Synchronous-condenser Unit.

A textile mill operating two 1,500-kw. noncondensing turbines in conjunction with a power system recently found it advisable to float one of these units on the line as a synchronous condenser during periods when power demand in the mill was low. The operators, after having some difficulty with the last stages of the turbine and the inboard bearing overheating, were overcautious in the amount of cooling steam admitted. As the turbine was run this way for several days at a time, the loss from the excessive use of high-pressure steam was considerable.

A simple arrangement (Fig. 112) was chosen to give positive control of cooling steam automatically regardless of the pressure or temperature of the steam admitted to the first stage of the turbine. The temperature-expansion element set in the exhaust line of the turbine was adjusted to operate at 260°F., several degrees above the normal operating back-pressure temperature. If overheating is caused by the turbine-blade friction as a result of insufficient cooling steam, the rise in exhaust temperature will cause the regulator to admit more cooling steam.

A low-pressure nonreturn valve was placed in the exhaust line between the turbine and the exhaust header. A simple receiver led down from the elbow to a low-pressure trap, and this took care of any condensate that might form before the check opened. An atmospheric relief valve was connected before the nonreturn and, in the particular case described, was set to open at 8 lb. gage pressure. The regulating valve was of a special type having the pressure acting under the diaphragm. With this arrangement, a relief valve of proper capacity should be provided in the exhaust system.

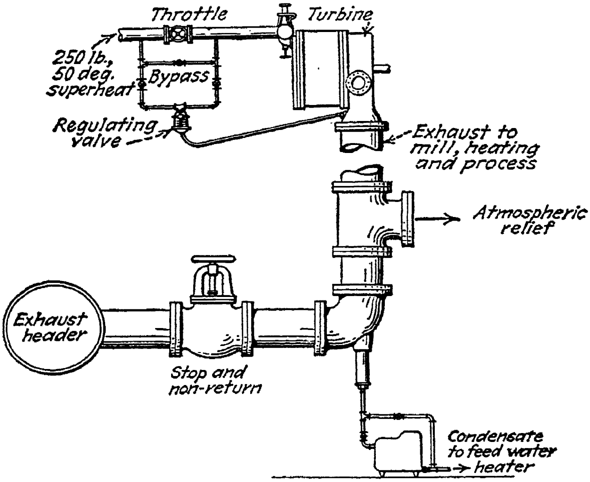

Throttle
Turbine
250 lb., 50 deg. superheat
Bypass
Regulating valve
Exhaust to mill, heating and process
Atmospheric relief
Exhaust header
Stop and non-return
Condensate to feed water heater

FIG. 112.—Arrangement to control cooling-steam supply.

Milford, N. J. H. M. SPRING.

341. Vacuum Problem.

A 500-kw. turbine-generator set was served by a barometric condenser which failed to produce better than 22 in. Hg of vacuum. Conditions were favorable (or should have been) for a much greater vacuum: cold water, full 34-ft. barometric leg, and no overload.

A ¼-in. cock, Fig. 113, had been tapped into the exhaust line from the turbine for a gage, but the gage had been removed.

One watch engineer, without any reason, opened this cock. The vacuum dropped about 4 in. momentarily, then shot up to 26 in. After a period of perhaps ½ hr., the vacuum had again dropped to 22 in. This stunt could be repeated time after time.

The hot well, built of concrete, was between two water-wheel tail races, one of the most dangerous and inaccessible spots imaginable. Even though served by an iron ladder, it was a hazard to inspect this concrete box.

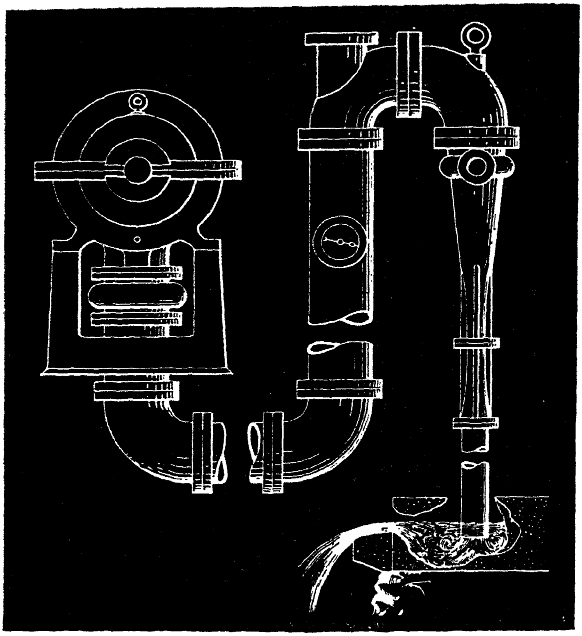


Fig. 113.—Flashboards cure trouble with overflow.

But, one day, the hot well *was* inspected, and the cock opened to admit air. Vacuum went up, and so did the water in the hot well, the air admitted allowing the water in the leg to drop suddenly and so raising the hot-well level. Normally, the seal was only 4 in. This was not enough, so flashboards were installed in the overflow. This cured the trouble.

Lawrence, Mass. C. J. Wilder.

342-347. Six Pointers on Carbon Packing Rings.

342. Almost every engineer who has handled turbines with carbon sealing rings has had more or less trouble with leakage, heating, breakage, etc. By using care and following instructions, it should not be necessary to take the ring casing apart more than once a year. The first thing to remember is to take your time fitting the rings, paying particular attention to getting the proper tension on the springs.

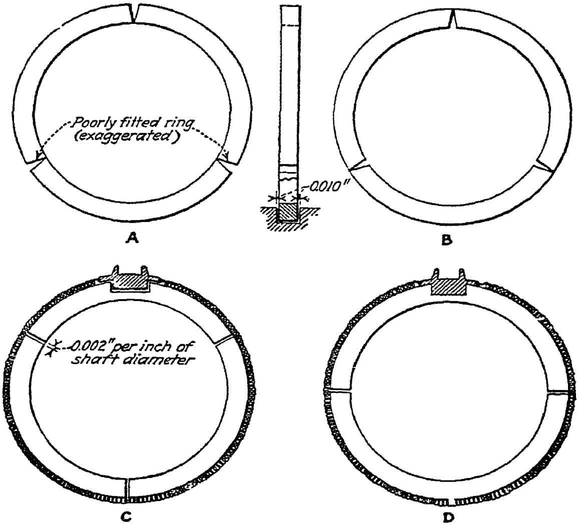

Poorly fitted ring (exaggerated)
0.010"
A
B
0.002" per inch of shaft diameter
C
D

Fig. 114.—Improperly and properly fitted carbon rings and keepers.

343. If the prongs on the keepers are too long, when you bolt the ring casing up you will crush or break them. This probably will not be discovered until the turbine is under steam. Then, again, if the prongs are too short, they may allow the rings to turn, which will mean broken rings, springs, and keepers, although with short prongs they may run along for some time before this happens. The best way to ascertain the right-length prongs is to have the rings made up in the lower half of the ring casing, cover the top of the prongs with red lead, and then lower the top half of the casing, using a feeler gage to check for an opening between the lower and upper halves of the casing. If both halves are closed—that is, no clearance between upper and lower halves, and the prongs are O.K.—the amount of clearance shown by the feeler gage will determine the amount that will have to be taken off the prongs. If, on taking the top half off again, you do not see any mark of the red lead, it is an indication that the prongs are a bit too short. The surest way is to have the welder build up the prongs and file down to a fit, using the method just described.

344. Care should be taken to remove the sharp edges from the rings with a dull file. They should have a side clearance of 0.020 in., and the clearance between the sections of a ring should be about 0.002 per inch of shaft diameter with ends fitted parallel as shown at *C*, not as at *A* and *B* (Fig. 114). When rings are made up on the spindle, they should have a fairly good spring tension.

345. When the rings have been properly fitted and you are ready to bolt up the lower and upper halves of the ring casing, be careful to tighten up the bolts where both halves join, before you tighten the bolts on the turbine casing. When you have all the bolts tight, try once more to get a feeler between the ring casing where both halves butt. If this shows no clearance, you are reasonably sure that you have a tight job. Now warm up the turbine slowly and run at reduced speed without load for about an hour, watching the ring casing for any sign of smoke or heating. With the turbine running slowly, the inside circumference is being ground down, thereby increasing the diametrical clearance between the spindle and the rings. At the same time, the clearance between segments is decreasing until the ends butt.

346. For high-pressure and superheat, allow 0.002 in. clearance between each two segments of ring per inch of shaft diameter when cold. Where superheated steam is not used, a little less clearance can be used, say about 0.0015 per inch of shaft diameter.

347. In order to make a nice job of fitting carbon rings, make sure the shaft is free from burrs, rust, scale, etc. Through carelessness or accident, this part of the shaft is sometimes burred or injured by hitting the ring casing or other heavy objects against it. In case of burr or roughness, use a fine emery stone and follow up with an oilstone until the shaft is smooth.

New Haven, Conn. PHILIP T. HYNES.

348-350. Three Tips on Refitting Turbine Packing Blocks.

348. Where carbon segments are used as packing in the sealing gland of a steam turbine, they must be fitted perfectly to the turbine shaft if best results are to be secured. If the fitting has been properly done, the rings will soon take on a high polish, conducive to small friction and wear.

349. When a turbine is overhauled, and the carbon blocks are found to be grooved or scored, they should be dressed down smooth again. Obtain a mandrel of wood or steel the same diameter as the turbine shaft. Stretch a piece of emery paper over the surface and hold it in place by bands or other means. Each block should be dressed on this paper until all scores or grooves are removed. The emery paper should then be removed, a paste of fine emery and oil made up, this applied to the form, and each block again bedded. This will improve the surface and remove any scratches left by the emery paper. When this is finished the paste should be wiped off, and each segment buffed. This will serve the dual purpose of giving a final finish and removing any emery grit that remains.

350. When repacking, all dirt or grit should be wiped from the gland, and care taken to see that the segments butt properly at the joints. The garter spring, which holds the packing to the shaft, should also be tested, and if found to be weak or corroded it should be replaced.

Hertfordshire, England. W. E. Warner.

351. Oil Cooler Change-over Shuts Down Low-pressure Turbine.

In a 1,400-lb. central station, some time after starting up, an incident occurred that nearly caused considerable damage to a turbine. The plant contains boilers supplying 1,400-lb., 750°F. steam to a high-pressure turbine of 11,800-kw. capacity. Steam exhausts from this turbine through a steam and flue gas reheater before entering the low-pressure turbine. The low-pressure turbine runs condensing and is rated at 43,200 kw.

Steam enters the low-pressure turbine through a valve known as the "intercepting valve." This is a balanced valve held open by oil pressure from the main oil pump acting against a heavy spring in the hydraulic cylinder at the top of the valve. The position of the intercepting valve is controlled by a pilot valve operated by the governor. On one of the rods to the pilot valve floating lever is a handwheel turnbuckle which permits manual control of the intercepting valve by varying the pilot-valve setting.

Under normal operating conditions, the intercepting valve is kept wide open, but during electrical storms when a trip-out is likely, it is kept slightly closed off so that if the high-pressure turbine should trip, the intercepting valve would close in time to prevent the low-pressure turbine from running away and also tripping off. This saved the turbine operator, whose station was at the high-pressure turbine, from having to run across and reset the low-pressure turbine before being able to start up again.

Some time after the plant had been in operation, the repair department was changing over from one oil cooler to the other. It had been some time since the second cooler had been used, and evidently an air pocket had formed in the oil system. By mistake, they opened the oil valves to the second cooler quickly, and the oil pressure immediately dropped too low to hold the intercepting valve open. Immediately, all safety valves opened in the reheat system, but the high-pressure turbine stayed on the line, and the low-pressure turbine kept running at synchronous speed, being motorized.

The chief engineer, finding oil pressure low, opened the throttle of the turbine-driven auxiliary oil pump but forgot the handwheel turnbuckle on the pilot-valve rod. The oil pressure built up in several seconds, opening the intercepting valve wide and throwing full load on the motorized generator almost instantaneously. Luckily, everything stood the shock, which must have been severe.

If the handwheel had been turned down, closing the intercepting valve, the oil pressure could then have been built up, and the handwheel slowly screwed up, allowing the intercepting valve to open slowly and the machine gradually to take the load.

Milford, N. J. HARRY M. SPRING.

352. Division of Turbine Load by the Increment Method.

The accompanying curves (Fig. 115) show a preferable method for arriving at the increment-rate curve. This is done graphically by using a total heat input-output curve to which tangents are drawn to determine the slope at any point. The slope of a tangent is found by dividing the difference between the ordinates

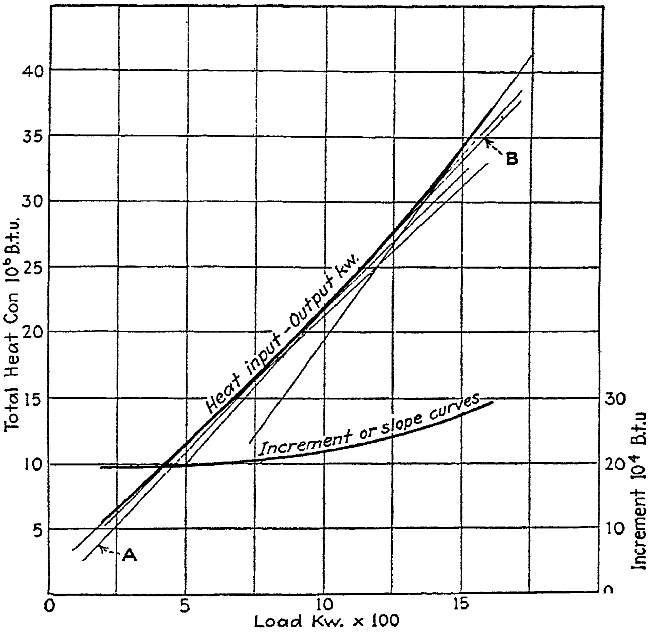


FIG. 115.—Graphical method of deriving increment curve.

at any two points *A B* by the difference between the abscissa at these points:

$$\frac{(35 - 4)\ 10^6}{(16 - 2)\ 10^2} = 2.21 \times 10^4$$

I think that this is the method usually used.

St. Louis, Mo. G. V. WILLIAMSON.

353. How to Lay Up a Steam Turbine.

When about to lay it up, pour oil into the turbine while it slowly turns over. I assume that a condenser would be situated below the turbine, in which event the oil would be driven into the bottom of the condenser. In such a case, remove a hand or inspection plate to give a constant drain for the condensate which forms under varying atmospheric conditions when the turbine is out.

Turbine equipment of the Cunard liner *Mauretania* is "laid up" at the end of each voyage for a few days. The procedure followed there was, in my time, to remove a blank flange at the base of the low-pressure turbine to obviate the collection of condensate after the turbine had been allowed to cool down. Obviously, care has to be taken that this flange is replaced before the turbine is put into operation, particular attention being paid to the joint to insure no loss of vacuum at this point.

Toronto, Ont. L. W. Ross.

354. Laying Up a Steam Turbine.

I should like to suggest that the turbine merely be shut down and that if the stop valve cannot be relied upon to remain tight, the steam pipe should be blanked off on the turbine side—not on the live-steam side—to prevent ventilation. The air pump will take away any remaining moisture, and with the machine sealed up it should be immune from any corrosive action. The introduction of oil, as suggested above, I think is asking for trouble.

London, England. D. H. Phillips.

355. Discharging Safety Valve into Low-pressure Turbine.

Discharging a safety valve into a low-pressure turbine is not in accordance with the A.S.M.E. code.

Possibly, an operator could leave the present safety valve and install another one set at 2 or 3 lb. lower pressure and discharge the lower-pressure valve into the turbine. In this way, he could save most of the steam now wasted and still be protected, as in case of back pressure, on the new safety valve. The original valve would blow to atmosphere, thus complying with the code. It might be well to install a valve in the new discharge line which could be closed frequently enough to be sure that the original safety valve was operating properly.

Racine, Wis. J. J. Wynhoff.

CONDENSERS

356-362. Seven Pointers on Retubing a Surface Condenser.

356. When a new condenser is to be tubed, it is best to make a wooden cover just the size and shape of the tube sheet and secure it against one tube sheet. One-inch finished boards 6 in. wide are good. The cover should be small enough to fit inside the water box but large enough to cover all tubes. If the condenser is large, it is well to make the cover in halves or even quarters, to facilitate erection and to allow part of the tubes to be packed while others are still being put in place.

357. Condensers have, as a rule, two or more support plates between the two tube sheets, so located that the tubes are about ¼ in. higher in the middle than at the ends. This facilitates draining, keeps sand and other particles from lodging in low spots, and tends to keep tubes from vibrating in the support plate.

358. When tubing the condenser, two men at least are required on the outside to handle and start the tube. Inside, there should be a man at each support plate and at the far tube sheet. The first tube should be started at one corner, so that workmen on the inside can find the corresponding places in the other plates easily. Tubes should be put in following straight rows, and each should be pushed all the way through until it hits the board cover at the other end of the condenser.

359. After tubes are in place, the wooden cover can be removed, the packing put in, and the ferrules screwed up. Ferrules should not be screwed up so that the shoulders come tight against the ends of the tubes. Care should also be taken not to tighten the packing too much, or the tube may be crushed when the packing gets wet and swells.

360. Many types of packing are available; corset lace which comes in long strings, sometimes soaked in paraffin, is probably most used. Proper length should be determined so that the ferrule will screw in far enough to leave just a little clearance between tube and shoulder. If this clearance is too great, the tube will gradually work over until all clearance is on one side. All packing should be cut the same length. When the tubes are packed, the steam side of the condenser should be filled with water, and the packing allowed to soak several hours before the water boxes are put on. Then the ferrules should be tightened to prevent leakage.

361. With practically all types of packing, including corset lace, it is well to use thin rings of fiber at the bottom of the packing space and against the ferrule. The corset lace should be wound in clockwise, and when the ferrule is screwed in it will tend to tighten the packing rather than loosen it.

362. When putting a few isolated tubes in an old condenser, it is impossible to have a man on the inside. In this case, it is well to take a length of small pipe and insert it in the tube before the old one is withdrawn. The pipe will guide the new tube. Packing and ferrules are put on the same as before, but the ferrule must be drawn up a little tighter, because it is usually not possible to let the packing soak for some hours before putting the condenser back into service.

Brooklyn, N. Y. P. F. ROGERS.

363. Easy Method of Replacing Condenser Tubes.

Replacement of condenser tubes that are badly worn is a rather slow and tedious job, and some of them are likely to tear apart in the center plate; when this happens, the holes in the outer tube heads must be plugged, as it is virtually impossible to get the pieces out, and new tubes in especially if time is limited.

To overcome this trouble, we use a rod 2 ft. longer than the tube, a sliding fit inside the tube bore. The ferrules are removed, the packing cut out, and the tube driven out with a tool the same size as the tube but hollowed out to fit over the rod.

When the tube has been driven out far enough to obtain a good grip at the other end, it pulls out easily. Then a new tube is led on to the rod and placed in position.

With this method, it takes only 5 to 10 min. to change a tube, and there is no danger of buckling or breaking at the tube center.

Holyoke, Mass. JOHN WINTERBOTTOM.

364. Cleaning Condensers without Taking Them Out of Service.

In one of the generating units in our plant, there is a 27,000-sq. ft., horizontal, two-pass, divided water-box surface condenser with 5,200 1-in. tubes. Circulating water is first pumped into a pressure tunnel, then up and out through the condenser to the discharge tunnel. The outlet has a 20-ft. drop, and this creates a vacuum, or siphonic head, in the circulating-water side of the condenser; consequently, starting head on our circulating pump is more than the head pressure after we have water going through the condenser.

With a clean condenser, we have just a slight vacuum at the intake gages and a reading on the vacuum side of the outlet gages equal to 9½ ft., the gages being compound foot-head gages. Drain lines from the first-pass water-box drain into the discharge line.

We used to drain the condenser and open the doors to remove the trash, but to our surprise we noticed on a few occasions that the tube ends were perfectly clean. In checking up, we found that if we drained the water before the pressure on the intake gage (due to trash) rose above 15 ft., we would get the tube ends clean and rid of trash by just draining, without opening the doors.

To remove the trash in this way, starting with the left half of the condenser, we close the air offtake to the jets from the left half, close inlet valve, open drain valve, remove plug (which is a vent), allow this half to drain about 5 min., then replace the plug, close the drain valve, and open the inlet valve and the air offtake valve. When this half of the condenser is again in service, we proceed in the same manner with the right half.

After we have cleaned both sides, we again close the inlet valve on the side we first cleaned, to be sure that we get rid of all the air on the water side. We go through this procedure with a load of 11,000 kw. on the unit.

Springfield, Ohio. GEORGE LUDWIG.

365-368. Four Causes of Air Leaks.

What causes high water in the glass of a condenser?

365. Without doubt, the area of highest vacuum will be at the point where the vacuum is produced. In a low-level jet condenser, leaky stuffing boxes will cause a flow of air through the water column toward the condenser proper, reducing the weight of water and causing a rise in the glass and more or less air bubbles. If possible to speed up the pump, as, for instance, in the case of a turbine-driven unit, this leakage may be overcome to some extent.

366. Trouble with gland seal through clogging of the small apertures might cause leakage. Of course the proper procedure is to flood the boxes from an outside source until necessary repairs can be made.

367. In the case of a surface condenser, leakage at the condensate-pump stuffing boxes will give the same result.

368. In a moderate-sized plant, one engine lost vacuum every morning regularly at about seven o'clock. This engine was served with a surface condenser, and the condenser, in turn, was served by a steam-driven, variable-speed reciprocating dry-air pump. No trouble was experienced during the night, but for one hour in the morning vacuum would fluctuate up and down. The chief engineer found his assistant screwing the governor down for more speed on the dry pump. At night, vacuum was lowered, as the load was light, but the first thing in the morning, when the assistant came on duty, he proceeded to speed up the dry pump, creating a higher vacuum in the condenser than the condensate pump was designed to operate against; there was very little head on the condensate pump, owing to a shallow basement, so the water would rise in the condenser and put it out of business.

New York, N. Y. C. W. PETERS.

369. Water Backup Alarm for Condenser Well.

Occasionally, we have experienced trouble from condensate backing up into the condenser well. To overcome this, we removed a handhole plate from the well and mounted on it a small float, as shown in Fig. 116. Then we drilled the plate to take a spark plug after extending and enlarging the conductor through the plug to make a contact on the other end of the rod. If the water level rises in the well, contact will be made on the end of rod through the plug.

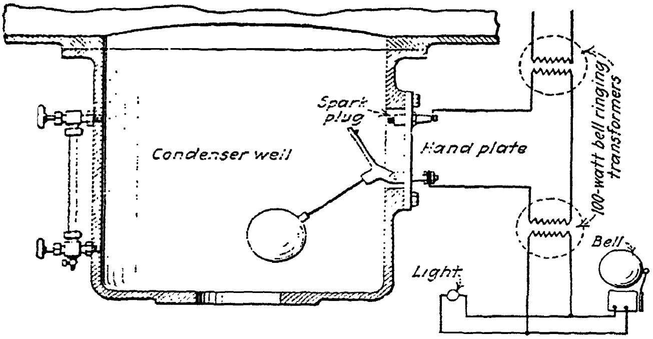


FIG. 116.—Diagram of condensate back-up alarm.

To complete the circuit, we purchased two small transformers of the bell-ringing type with a capacity of 100 watts or more and a ratio of 110 to about 20 volts. We connected the high side of one transformer to the lighting circuit, then connected the 20-volt side of the two transformers together but looped the circuits through the contacts of the float, as shown. The second transformer was used to step up to 110 volts so that a standard lamp could be used on the light signal as well as a standard 110-volt alternating-current bell.

San Bernardino, Calif. V. E. Johnson,
Superintendent of Steam Plants,
Southern Sierras Power Co.

370. Reduced Water Flow Caused Trash Accumulation in Condenser.

One turbine was served by a single-pass condenser divided into an upper and lower deck. One 30,000-g.p.m. circulating-water pump was provided for each deck. Discharge valves on these pumps were normally in any position from one-half to wide open, depending on turbine load.

During a cold part of last winter, when the temperature of the circulating water was down to 32°F., it was decided to throttle down the discharge valve on the circulating pump for the lower deck of the condenser until a very small quantity of water was flowing. This was done, and no change in vacuum was noticed.

This idea worked fine for several days, when it was observed that vacuum on the turbine had dropped from 28.65 to about 26 in. Inspection of steam-air jets, dry vacuum pumps, and atmospheric valves failed to indicate any air leak, so cooling water was next given attention. The discharge valve on the bottom deck pump was opened a little more. Vacuum quickly went back to normal but in a short time began to drop again. The valve was again opened a little more, with the same result.

The bottom deck of the condenser was then opened for inspection, and it was discovered that, with the circulating-water pump throttled, only part of the lower rows of tubes were being supplied with water. All the leaves, sticks, and other refuse in the water that had got by the traveling screens had been concentrated on the several lower rows of tubes instead of being uniformly distributed over the entire tube sheet area. This had caused a cross section of tubes to become fouled in a comparatively short time. While it is true that the water level would rise enough to flow through clean tubes, velocity would be greatly reduced. Increasing the valve opening produced the same result. It was decided then that a saving on circulating-water pump power was more than offset by the difficulty experienced.

Milford, N. J. HARRY M. SPRING.

371. Flooding a Barometric Condenser.

Our steam-turbine exhaust pipe was 20 in. in diameter, and we never had any trouble at loads above 50 per cent of capacity, but sometimes on Sundays, when one of the turbines was running alone at about one-fourth load, the exhaust pipe would be almost cold back to the turbine, and some water would accumulate. It was our practice to wait until a slight knocking showed that enough water had accumulated to cut down the area of the pipe, and then we would open a valve to break the vacuum and shut off the injection water to the condenser.

As soon as the vacuum was lost, two 2-in. swing check valves on the bottom of the pipe would automatically open and allow the water to run out. We had to do this every 2 hr. during the day until the load increased considerably toward evening. Once water had accumulated to such an extent that it surged back into the turbine, and a number of blades were torn out.

A good vacuum trap that uses a tilting receiver and has a live steam connection will avoid trouble. While accumulating the water, the steam connection and the discharge are closed; then, when the trap tilts, the connection to the exhaust line is closed, steam is admitted, and the water discharged through the outlet to the boiler or receiver.

Cambridge, Mass. G. H. KIMBALL.

372. Flooding a Barometric Condenser.

Unless an exhaust pipe between engine or turbine and barometric condenser, where there is a horizontal section below both turbine and condenser, is properly drained, there is likely to be an accident sooner or later. There are vacuum traps that will perform this service when they are in perfect working order, but there is seldom any indication that the trap is not performing its function until something unusual and disastrous occurs.

There is but one safe method: to install a receiver of considerable capacity below the lowest point in the exhaust line and to drain the latter to the receiver through a fairly large pipe. Condensation will collect in the receiver and can be automatically removed with a hot-well pump in much the same manner that a surface condenser is drained, and a simple telltale can be attached to indicate continuously that the hot-well pump is operating as it should.

Providence, R. I. WARREN B. LEWIS.

373. Condenser Hot-well Alarm System.

There are numerous alarm devices in use to give warning of hot-well pump failure. Nearly all are based on some type of float switch and operate when the water level rises into the condenser beyond some predetermined safe point. In many cases, however, if the warning is not given until the water rises into the condenser, it will usually be too late to prevent a shutdown and possible damage.

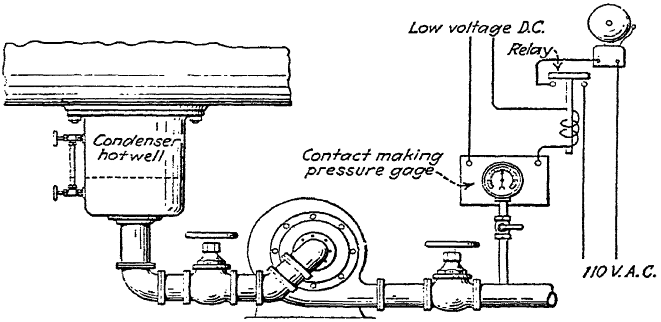


FIG. 117.—Contact-making pressure gage on pump discharge gives instant warning of pump failure.

A standard pressure-contacting gage on the hot-well pump discharge, as shown in Fig. 117, will give the alarm as soon as trouble occurs at the pump, thereby allowing a longer time in which to correct the trouble. In the installation shown, the contacts on the gage are set to connect at 2 lb. pressure.

Boston, Mass. H. M. SPRING.

374. Water Shortage Caused by Dirty Condenser.

Overhauling a pumping station revealed an unsuspected cause of trouble.

Water was obtained from artesian wells, and a shortage of water made the pump pound if run at full speed. Thinking that the supply was failing, we decided to drive more wells.

We also decided to overhaul the condenser and remove several split tubes. The condenser was the standard waterworks type connected directly to the pump suction so that water from the wells flowed outside the tubes. It contained 300 tubes, $\frac{3}{4}$ in. in diameter by $6\frac{1}{2}$ ft. long, and the shell measured 42 in. in diameter.

When we opened the plates on the ends, we found about 50 leaking tubes. After marking the leaky ones, we made a punch to drive them out. But it was impossible to drive the tubes out. We opened the manhole plate on top of the condenser and found the bank of tubes one solid mass of mud. The tube bank cleared the shell by about 4 in., and this was the only passage the water had.

We tried washing the mud away with a hose, but this moved but a small quantity near the outside. We finally decided to bring the whole bank of tubes upon the engine-room floor. Even then, we found that it would take considerable time to remove the mud and properly clean the tubes, so we cut them out, both good and bad. It took two men two days.

Putting the tubes in was a simple matter. After we finished packing them, we started the pump. At the fastest speed, the pump obtained plenty of water.

Rosedale, L. I. JOSEPH O'BRIEN.

375. Reduced Steam Consumption of Air Evactor.

The work done, and hence the steam required, by the air evactor on a surface condenser depends on the quantity of noncondensable gases to be exhausted and on the difference in pressure between condenser vacuum and evactor discharge pressure, which is usually atmospheric. The quantity of gases to be discharged cannot be decreased appreciably beyond a certain point. Since there is little chance of reducing the amount of vapor to be removed, the only possibility of reducing steam consumption of the air evactor is to reduce the evactor discharge pressure. This can be done easily by piping discharge to the circulating-water outlet, as shown in Fig. 118.

A vacuum of 10 to 20 in. of mercury, due to head and water velocity, usually exists at the point of connection as shown, if its height is 10 to 20 ft. above the circulating-water discharge to tidewater or river level. The circulating-water pump must, of course, operate in the inlet side of the condenser, because, if not, the condenser will lose its water, or the pump will become airbound. If the circulating-water outlet from the condenser is the bottom pipe, instead of the top, the vacuum at the point of connection will be less but will still be enough to effect a saving in air-ejector steam consumption. If the evactor is equipped with a condenser or cooler, it is necessary to connect a trap at a low point in the piping to collect condensed steam.

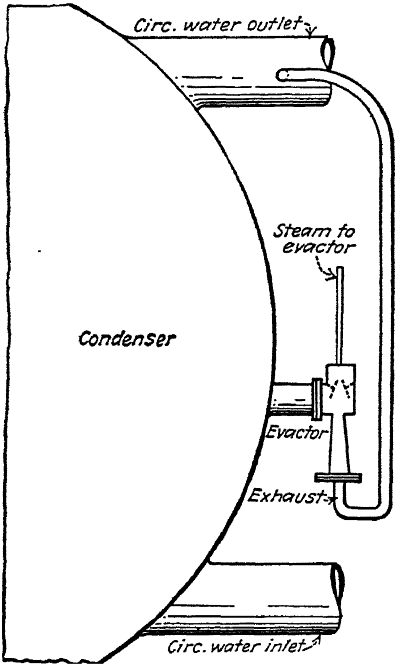


FIG. 118.—Exhaust of air ejector connected to circulating-water discharge reduces steam consumption.

Astoria, N. Y. GORDON R. HAHN.

376. Draw Water through Condenser.

Operation of a high-pressure boiler requires pure feed water, which has resulted in frequent application of evaporators to produce the make-up feed. It is customary to require the manufacturers of this apparatus to guarantee the chemical purity of the distilled water.

However, use of even the purest make-up will be of little consequence if the condensate is being constantly polluted by condenser leakage.

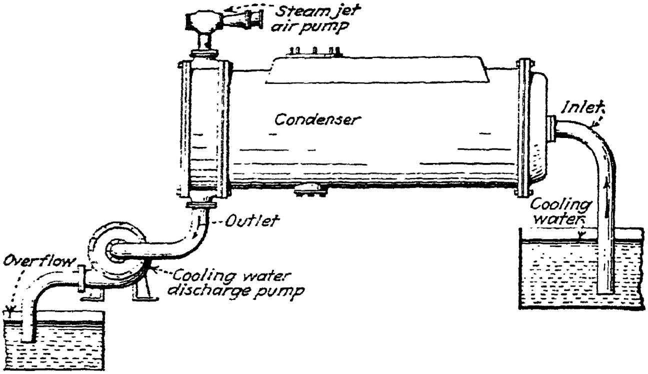


FIG. 119.—Proposed arrangement for drawing instead of forcing cooling water through condenser.

Modern practice has proved that it is feasible to keep condenser-tube joints tight at both ends by expanding the tubes into the plates. Nevertheless, it is desirable to reduce cooling-water pressure as much as possible. For instance, cooling water could be drawn into, instead of being forced through, the tubes, as in Fig. 119. This is simple and practical but will necessitate priming of the circulating system with an air pump, which must be connected to the highest point.

Berlin, Germany. W. GRINBERG.

CHAPTER VI

ELECTRICITY

377-380. Four Pointers on Proper Fusing of Circuits.

377. Fuses lend themselves readily to abuses. They can be improperly filled, which may lead to overloading the equipment they are to protect or cause the fuses to fail at loads below rating.

378. Pitted fuse clips should be replaced, because it is almost impossible to repair them, the tension being usually destroyed by arcing and heat of poor contact. A fuse may not be loaded near its capacity but may still fail from local heat, owing to poor contact. Pitted contacts are caused by overloaded fuses, overfused clips, and dirty fuses. Often the clips will be found to make contact on one side only. This condition may be remedied with a pair of pliers.

379. In refilling fuses, care should be taken to brighten the contacts with a fine emery cloth. A screw driver should be used to tighten the ferrules or the link screws, because a firm contact cannot be made with the hand alone. They should not be made too tight. If the contact points or surfaces in a refillable fuse are pitted so that a fine file will not smooth them, it is cheaper to replace them than to risk a delay caused by a blown fuse.

380. The main fuses in a distribution box should seldom blow. The smaller fuses should blow first and save the larger ones. If these do not, some circuit is overfused, or the main fuses are too small, or they are not making good contact in the clips. I seldom use refillable fuses on the mains, because main fuses give little trouble when installed properly.

Birmingham, Ala. GRADY H. EMERSON.

381-385. Five Helps in Testing and Keeping a Record of Fuses.

By means of the tester, illustrated fuses of the cartridge and plug types, as well as standard screw-base lamps, can be quickly tested.

381. Two $\frac{1}{8}$- by $\frac{1}{2}$-in. copper bars are screwed to a small slate or ebony asbestos panel, as in Fig. 120 (left), and arranged to be spanned by the longest and shortest cartridge fuses in use. Maximum and minimum distances of 10 and 2 in. between bars are generally suitable. At the bottom of the bars, terminals are provided for attaching leads when necessary for testing other apparatus.

382. Lamp and plug fuses are inserted in socket *A*. The threads of the brass shell of this socket should be flattened so that the device to be tested need be but pushed into the socket. *B* and *C* are small 110-volt lamps connected in series with the testing bars. These lamps glow at half voltage when a fuse tests good.

383. The tester is fully inclosed by a hinged door, or cover, made of ebony asbestos. A double-pole snap switch is connected as at right. Above it, a pilot lamp indicates when the tester is energized. The latter should be connected to a circuit that is continuously energized. Wiring is done in conduit, and the tester should be securely bolted to the wall.

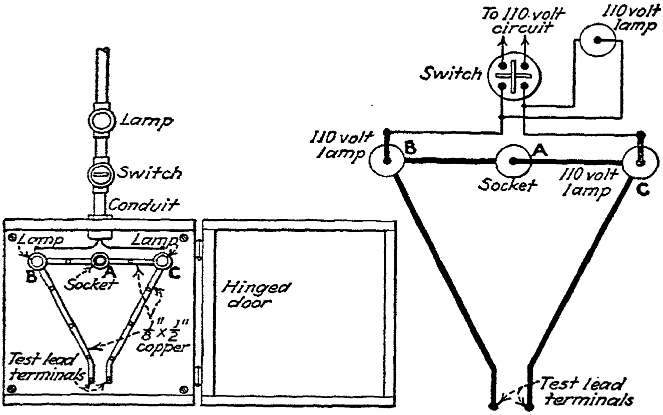


FIG. 120.—Test panel for fuses and lamps.

384. A supply of spare fuses and reloading links is usually kept near a fuse tester of this type. One method of keeping links and assembled fuses in good order is to provide pigeonhole compartments in a cabinet. Fuses and links of each rating should be kept separately, and the contents of each compartment should appear on a suitable tag, or name plate. The ampere rating of each fuse should be indicated, small numbered stickers being suitable.

385. To avoid mistakes when replacing fuses, the ampere capacity should be marked near each fuse, and a list of all fuses used in that particular department should be posted near the fuse cabinet. One method of listing fuses is shown in Figs. 121 and 122. Required fuse capacities are sometimes indicated on stamped plates attached to the doors of safety switches and fuse boxes.

COMPLETE FUSES						RENEWABLE LINKS					
Amp.	Volts	Quantity		Form	Designation	Amp.	Volts	Quantity		Form	Designation
		Max.	Min.					Max.	Min.		
400	*600*	*6*	*3*	*Cart.*	*CR400-6*	*400*	*600*	*18*	*12*	*A*	*L400-6*
20	*250*	*16*	*8*	*Plug*	*P20-25*	*30*	*600*	*30*	*10*	*A*	*L30-6*

Fig. 121.—Form for listing spare fuses and links.

APPARATUS FUSED		Protection for	Connected to Cir.	Number of Fuses Req.	FUSE TO USE				Remarks
Name	No.				Amp.	Volts	Form	Designation	
Pr. Fdr. Sw.	*401*	*Cir.P401*	*P401*	*3*	*400*	*600*	*Cart.*	*CR400-6*	*None*
Motor Sw.	*415*	*Motor 51*	*P401*	*3*	*100*	*600*	*Cart.*	*CR100-6*	*None*

Fig. 122.—Form for listing fuses in service.

Pittsburg, Calif. Robert Ball.

386. Dummy Fuse with Extension Blade Facilitates Testing in Industrial Plants.

Although the use of dummy fuses and cables for testing power consumption on 220-, 440-, and 550-volt circuits, by using different size fuses, is probably well known, the method of using one fuse for different capacity circuits will, I think, be new to many.

Instead of separate fuses for each voltage range, a 250-volt fuse is used. When testing is to be done on 440- or 550-volt circuits, a simple blade extension is slipped over one of the blades and fastened in place with a thumbscrew, which passes through a hole drilled in the blade, as in Fig. 123.

In this way, the stock of dummy fuses and cables is about one-half that formerly necessary.

Westminster, B. C. W. L. Stevens.

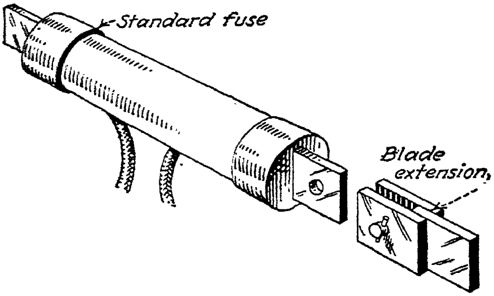


Fig. 123.—Standard fuse with blade extension.

387. Fuses and Thermal Cutouts Protect Three-phase Motors.

There are many solutions to the problem of preventing single-phase operation of three-phase motors. The least expensive remedy is thermal cutouts. Each motor should have a separate set of thermal cutouts, and the main switch should be fused at the capacity of the feeder. The thermal cutouts will open when there is trouble or overload on the motor it is protecting. The main fuses are backup protection, to take care of short circuits on the feeder. Thermal cutouts may be obtained to protect motors of any rating.

If a motor installation warrants better protection than the thermal cutouts and fuses will provide, a phase-balance current relay may be installed and will protect against running, in case of polyphase unbalances that cause undue heating; against running with one phase open; against running with a phase reversal; and against operating under dangerous overload or short-circuit conditions.

Raleigh, N. C. G. E. Pickett.

388. Single-phase Operation Blows Motor Fuses.

Several three-phase motors were supplied from a two-phase line through Scott-connected transformers. They operated satisfactorily for a while; then a condition similar to single-phase operation seemed to exist, and the fuses on the motors opened. Examination of fuses at the transformers and at the main switch and branches showed everything all right. It was not until voltage measurements were made that the trouble was discovered.

The connections at left (Fig. 124) give a uniform voltage on the three phases. When the voltage measurements were made the conditions were found to be as those at right, which are those obtaining when both transformers are connected to the same phase. At first this was puzzling, but a search of the circuit revealed a switch that had been in use at one time to transfer load from one phase to the other. When no longer required, the switch was closed to the *B* phase and forgotten. No more was thought about it until one day an attendant threw it to the other position and in doing so connected both transformers to the same phase.

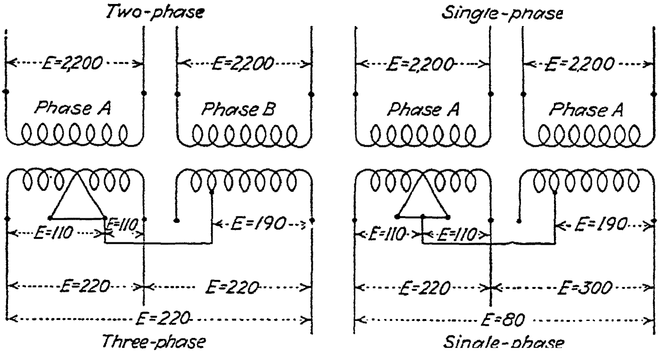


FIG. 124.—Left, transformers connected to change two- to three-phase power; right, voltage distribution found on the transformers on single-phase operation.

Patchogue, N. Y. HENRY MULFORD.

389. High Temperature Causes Fuses to Blow.

Proper attention is frequently not given location of fuse blocks in regard to temperature. A speed-control box for an automatic stoker was mounted against the brickwork on the side of the furnace wall. Main leads to the stoker motor ran through fuses inside this box. Some time after the plant was placed in operation and the boiler was operating at a high rating the fuses blew out several times.

Electrical connections were checked and found not at fault. Then the engineer discovered that the temperature of the fuse box was around 120°F. owing to heat conduction through the furnace wall. This temperature was sufficient to cause the fuses to open at full load. The control box was removed, and several sheets of insulating material were put between it and the wall. After this there was no further trouble.

Milford, N. J. HARRY M. SPRING.

390. Auxiliary Relay Silences Alarm Devices.

One purpose of an alarm system is to advise the operator when certain protective relays function. Extra contacts or auxiliary relays provide means of connecting a reset to the alarm circuit to stop the sounding of the bell or horn. Some protective relays, however, cannot be reset immediately. An example is the thermal relay, which requires time to cool before it can be reset. In some cases, a snap switch is connected in the bell leads by the switchboard men, and they forget to close the switch after cutting out the alarm. To avoid this, a relay and connection, as shown in Fig. 125, are recommended.

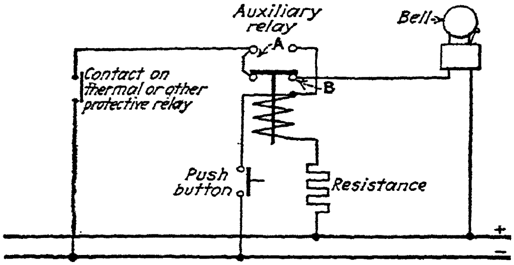


FIG. 125.—Diagram of alarm cutout circuit.

When the contacts of the protective relay close, the bell is energized through the *B* contacts of the deenergized auxiliary relay. The operator can immediately stop the bell's ringing by pushing the button. This closes auxiliary relay contacts *A* and completes a circuit for the relay coil through these contacts and the contacts of the protective relay. This operation also opens the bell circuit through contacts *B*. When the protective relay cools down or otherwise returns to normal, and its contacts are opened, the auxiliary relay is deenergized and drops back ready for duty again.

Philadelphia, Pa.

A. C. FINNEY,
Switchgear Department,
General Electric Co.

391. Simple Ground Detector.

I constructed a simple ground detector using 250-volt 16-cp. carbon lamps, two in series, star connected, with a 1-amp. fuse in each line. The star point was connected to a permanent ground, as shown in Fig. 126. A steel cabinet was used. The fuse cutouts were mounted inside, and the lamps were mounted on the lid with sign receptacles. It was installed on the wall in the electrical office in a prominent position. A portable detector on the same principle, but mounted in a wooden box with carrying handle and 20-ft. extension leads with insulated clips at the ends, was also made to locate trouble on the distribution lines.

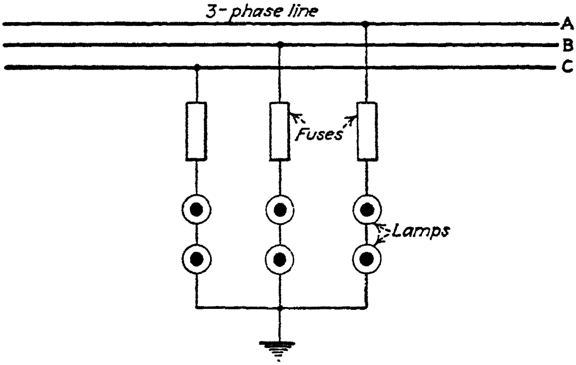


Fig. 126.—Connections using lamps to indicate grounds on motor circuits.

A ground coming anywhere on the system will be indicated on the lamps. For example, a resistance ground will be apparent by the uneven burning of the lamps, and a dead ground on one line will cause two lamps to go out and the others to burn brightly.

Toronto, Ont. Ellis Mills.

392. Sensitive Ground Recorder for Low-voltage Systems.

At our plant, a large number of motors are installed. It was felt that the lamp ground detector was not sufficiently sensitive to warn of impending trouble. A new ground detector and recorder was therefore installed. While it can be constructed by the average mechanic, it is sensitive and will detect and record all current leakage on the system to which it is connected.

The detector is similar to the one described above. The star point is connected to a permanent ground through a sensitive relay *A* (Fig. 127), so connected that current leakage to ground will flow through its coil.

When this relay closes, an auxiliary 110-volt circuit is completed through its contacts. This, in turn, energizes a small bell transformer *B* and also lights the 50-watt bulbs in the recorder, which illuminates the chart.

The transformer secondary-circuit current operates a second relay *C* which closes the recorder circuit, energizing its coil, which in turn attracts the armature to which is connected the pen arm.

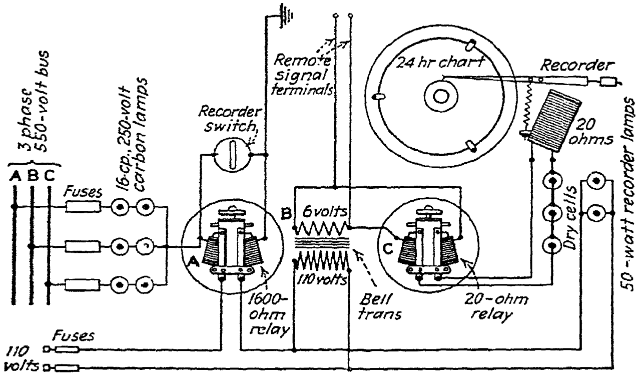


FIG. 127.—Ground recorder.

The pen is drawn across the chart, recording the time and duration of the current leak. Terminals are provided for a remote signal gong or pilot light to operate simultaneously with the recorder. The recorder switch is used to bridge the recorder when it is desired to use the detector only. The instrument is installed in the electrical shop where it is at all times in view of the man on duty. The recorder does not normally measure the current leakage but records the time and duration only. Provision is made to insert a recording ammeter if it is desired to study the behavior of any particular effect.

A portable detector on the same principle, but without the recording chart, mounted in a hardwood box with a carrying handle and 20 ft. of extension cord with insulated clips at the ends was constructed to locate trouble on the distribution lines.

Toronto, Ont. ELLIS MILLS.

393. High-voltage Testing Set Made from Old Transformer.

When testing motors designed for 440 volts and above for grounds, the usual 110-volt test circuit is not very reliable. To obtain a more thorough test, I made a testing equipment from an old 1-kva. transformer. The transformer had a voltage rating of 2,200 to 220 and 110 volts.

As the motors to be tested were for 440 volts, 1,110 volts was sufficient. To obtain this, the two high-voltage windings of the transformer were connected in parallel, as in Fig. 128. The low-voltage windings were also connected in parallel and to an attachment plug so that the transformer might be plugged into any convenient 110-volt outlet.

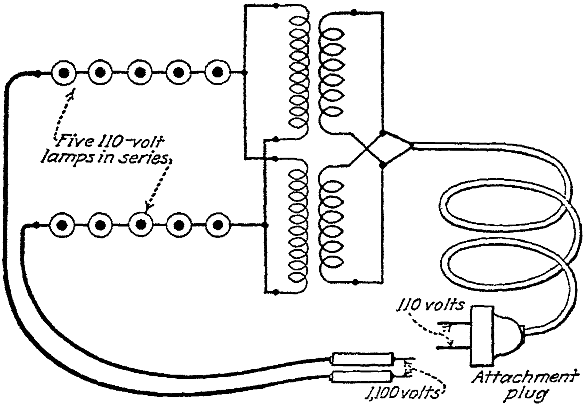


FIG. 128.—Connection diagram for testing transformer.

To prevent blowing the fuses in case the 1,100-volt leads are connected to a dead ground, five 110-volt lamps are connected in series with each lead. Test leads from the lamps are made of heavily insulated flexible wire with a short piece of rubber hose taped at the ends of the leads, so that they can be safely handled. A solid copper test point is soldered to each lead. To make the unit as compact as possible, the lamps are mounted on a small panel and attached to the back of the transformer.

As long as the insulation does not break down when making the ground test, it is subjected to 1,100 volts, which is sufficiently high to break down any weak spots in the insulation that would be likely to give trouble on 440 volts.

Philadelphia, Pa. CHARLES A. ARMSTRONG.

394. Ground Detector for Three-phase Circuits.

For use on 2,300-volt, three-phase normally insulated circuits, a ground detector may be made from three small potential transformers and three lamps connected as in Fig. 129. The transformers are of a design suitable for the full voltage of the line and the lamps as selected for the normal secondary volts of the transformers. As long as the system is insulated, each transformer is subjected to the star voltage of the system, or 58 per cent of line-to-line volts. Consequently the voltage on the lamps will be only 58 per cent of normal secondary value, and they will be dimly lighted.

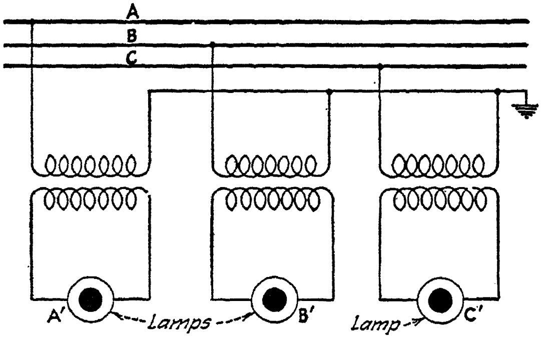


Fig. 129.—Three transformers connected as ground detectors on a three-phase line.

With a low-resistance ground on one line, the lamp connected to the transformers on this line will go dark, and the other two will light up to normal. For example, a low-resistance ground on line *A* will cause lamp *A'* to go dark and lamps *B'* and *C'* to light up to normal. This is because the ground at *A* short-circuits the transformer connected to that line and applies full voltage to the transformers connected to the other two lines. If the ground at *A* had a comparatively high resistance, lamp *A'* would be dimmer than normal, and lamps *B'* and *C'* would increase in brilliancy but not to full-voltage condition. Any change in the brilliancy on the lamps indicates a ground on one line, the fault being on the line to which the dimmest lamp is connected.

Butte, Mont. RALPH E. MACKAY.

395. Red Light Warns When Fan Is Shut Down.

In our plant, woodworking refuse is burned under one of the boilers. This refuse is collected from several machines by a number of blowers and delivered through several pipes into a main pipe leading into the boiler room. In this large pipe is a fan that must be in service when the others are running to take the refuse from the main pipe and deliver it to the boiler.

On two or three occasions the main fan motor stopped, and the stoppage was not discovered until the other fans had clogged the main pipe with refuse. In each case, it was a considerable job to clean out the pipe before the fan could be started. The proper thing to have done would have been to interlock the motor controls so that the auxiliary fan motors could not be started until the main motor was running.

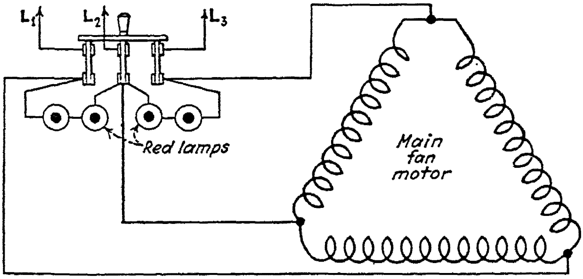


FIG. 130.—Red lights warn when fan is shut down.

Money was not available for such interlocks, so red lamps were used to indicate when power was on the motor main-fan terminals. The motor operated on 220 volts, and two 110-volt, 10-watt red lamps were connected in series across each pair of motor leads, as in Fig. 130. These lamps were in the fireroom where they would easily be seen by the firemen. If they went dark when the plant was in service, it was a case of hustle and shut down the other fans.

Buffalo, N. Y. A. C. ARNOLD.

396-399. Four Pointers on Determining Induction-motor Output with an Ammeter.

When load tests are made on motors, a wattmeter is generally used to obtain power input in order to calculate power output. Even when power input is known, it is necessary to assume a motor efficiency to calculate horsepower output. Since factory test data covering the performance of a motor under test are seldom available, an efficiency must be assumed. This immediately introduces a possible source of error, depending on the observer's guess.

396. A simpler method has been developed that requires the tester to measure the motor current only. It may be applied to either alternating- or direct-current machines. The only instrument required is a Tong-test ammeter that can be connected to the circuit by closing trigger-operated jaws around one of the line wires.

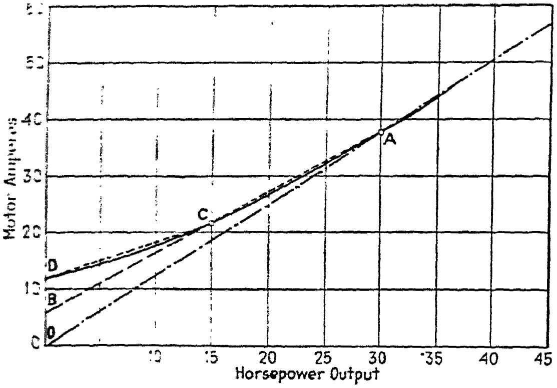


FIG. 131.—Charted motor-test curves.

397. Take, for example, a typical squirrel-cage induction motor. The full-line curve in Fig. 131 is actual line amperes plotted against horsepower input for a 30-hp., 440-volt, three-phase, 60-cycle, 900-r.p.m. motor. The dotted curve was approximated by means of the ammeter method. The error by the simpler method is so small that it may be practically disregarded.

398. The dotted test curve is plotted as follows: Point *A* is full-load amperes given on the motor name plate. Point *D* is obtained by measuring the motor's no-load current with the ammeter. Draw dash-and-dot line *OA* through zero and full-load point *A*, extending it to take care of overload if required. Next draw the line *BA*, with *OB* made ½ *OD*. Then draw *DC*, point *C* being the intersection of line *BA* and the 50 per cent horsepower output ordinate. Thus, there has been constructed an approximate curve *DCA* of line amperes and horsepower output. From this curve, the horsepower output corresponding to current input for any load may be readily determined.

399. In the specific case of this 30-hp. motor, the full-load current rating is 38 amp., and the measured no-load current of the motor is 12 amp. Therefore, *OB* is 6 amp. The curve *DCA* may be constructed, and any horsepower output determined by measuring the line amperes at a particular load. For example, if the ammeter reading is 30 amp., the load is about 22.5 on the constructed curve *DCA*. The actual load at this current, as shown on the factory test-data curve, is about 23 hp., a difference of only about 2 per cent. Even if a wattmeter is used to measure input, and the efficiency were assumed as in the ordinary way, it would be difficult to get a higher accuracy than obtained with the ammeter.

Cleveland, Ohio. M. M. ROSE,
Chief Engineer,
Columbia Electric Manufacturing Co.

400. A Simple Method of Checking Synchroscope Connections.

Two engine-driven alternating-current generators had been operated under load but had not been synchronized. It was my job to check the synchroscope connections and parallel the two generators. Phase rotation of the machines was O.K., as load had been carried by each machine. Where it is necessary to check phase rotation, common procedure is to connect a polyphase motor to the bus and determine if its rotation is the same when operated from either generator.

To check the synchroscope, we disconnected the generator leads at one machine. With the other generator connected to the bus, we closed the idle machine switch to energize its synchroscope potential transformers. The synchroscope indicated synchronism (as it should, because both synchronizing potential transformers were energized by the same potential, and as it happened both were connected correctly to the synchroscope). The idle generator switch was then opened, the generator leads reconnected, and it was now ready to synchronize. The generator was started, and, by waiting until the synchroscope pointer had almost stopped and was within a few degrees of reaching the top, it was a simple matter for me to put the two machines together.

Montague City, Mass. MAX PAFENBACH.

401. Weak Magnets Cause Wattmeter to Overregister.

For about two years, the power supplied to a 13,200-volt, three-phase distribution line increased. No reason could be found for this increase, as there was little change in connected load. The meter was connected as in Fig. 132. Investigation over several months failed to reveal any of the usual causes for a watt-hour meter registering too fast. As a last resort, a new set of retarding magnets were substituted for those on the meter. The meter was then tested and found to be within 1 per cent accurate, and the meter readings became normal.

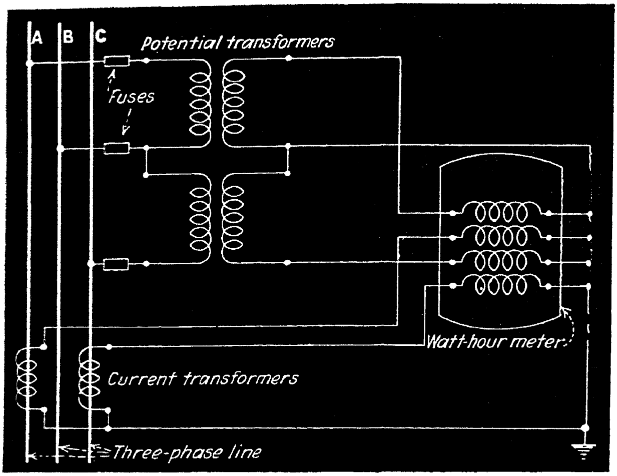


FIG. 132.—Wattmeter connections. Weak magnets caused over-registering.

Guthrie, Okla. V. K. STANLEY.

402. Markers for Indicating Wattmeters.

We have over 100 indicating meters of the horizontal edgewise type on our main switchboard, and the operator takes hourly readings from about 25.

We find it a great help to mark each meter with its circuit name or number. Our method of marking is to use labels lettered with waterproof drawing ink on ordinary white writing paper. A strip ½ in. wide by 1½ in. long is suitable and does not obscure the scale. Wattmeters with a zero center are marked "in" and "out" (tie lines). The labels are pasted on the *inside* of the glass in a central position at the lower edge.

The adhesive we use to attach the paper to the glass is called "flexible colloidion" and can be had at any drugstore. A camel's-hair brush is used to apply it to the glass, and then the label is placed and pressed down with the thumb. It must be worked fast, as this material dries almost immediately after applying.

The label can be seen clearly through the colloidion and will not yellow so much as it would with varnish.

Nashville, Tenn. THOMAS E. MILLER.

403. Voltage Regulators Failed to Operate in Parallel.

Some time ago, two 25,000-kva., 13,000-volt waterwheel generators were installed and connected to a common generator bus. There was an exciter for each machine. Regulator voltage was taken directly from each set of generator leads between machine and oil switch.

Because of the short distance between the two machines, some form of line drop was necessary in order that each regulator work as it should. Two line-drop compensators were obtained for this part of the voltage regulation. When the two regulators were put in service it was found that operating them together was almost impossible. They were continually pulling apart, and one regulator would stop entirely.

Some time later the conditions came to my attention. I had the operator take a series of readings of load together with the action of the regulator and its exciting current. From these data I figured that the trouble lay in adjustment of the regulator. I then started testing regulator effect on voltage and found one tending to raise the voltage as the load increased while the other lowered the voltage. The regulators were adjusted for flat voltage from no load to full load and are now working in parallel satisfactorily.

Great Falls, Mont. B. W. HAMILTON.

404. Testing Transformers Must Have Sufficient Capacity.

When making high-voltage tests on large generator windings, power capacity necessary to supply the charging current of the windings must not be overlooked. The windings of a large generator act as a high-capacity condenser and require a fairly large power capacity in the testing equipment to supply the charging current. This was demonstrated in a test made on the windings of a 28,000-kva., 11,000-volt waterwheel generator after rewinding.

The most convenient transformer for supplying the test voltage was a 50-kva., 11,000- to 32,000-volt unit. When this transformer was connected to the generator windings it was found to be too small to supply the charging current, and the voltage could not be raised to the required test value. When a 150-kva. transformer was substituted for the 50-kva. unit, the test was completed in a satisfactory manner.

Buffalo, N. Y. M. C. MAGUIRE.

405. Open-delta and Closed-delta Banks of Transformers in Parallel.

Connecting a closed-delta bank of transformers in parallel with an open-delta bank is easily done (Fig. 133). The logical solution is connecting an impedance in series with the single transformer and thus increasing the capacity of the banks from

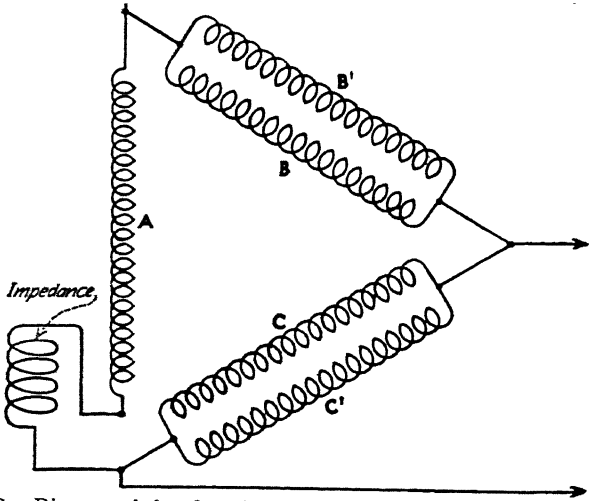


FIG. 133.—Diagram of closed- and open-delta banks of transformers in parallel, with an impedance in series with transformer *A* of the closed-delta bank.

80 to 95 per cent. This impedance would have to increase the percentage impedance of the single transformer by approximately 40 per cent in order to be able to load the banks to 95 per cent of full rating.

Lynchburg, Va. H. D. FORSYTH.

406-411. Six Pointers on the Care of Commutators.

406. Many operating engineers make a practice of lubricating the surfaces of commutators on direct-current generators and motors with wads of cotton waste saturated with engine oil or vaseline. This is done to reduce incipient sparking of the brushes and to keep them from chattering. But the relief is only temporary and must be repeated from time to time. Such lubrication is objectionable because it tends to produce gummy accumulations around the brushes and between the commutator segments. It is unnecessary if the commutators and brushes are kept in perfect condition. The brushes themselves will supply enough lubrication, especially if they are of graphite, provided the commutator be kept clean and smoothly polished. Where the commutator is kept truly cylindrical and even from end to end and is free from abrasions, a single set of brushes may last from two to four years. The same set of brushes on a neglected commutator might not last six months. To keep a well-conditioned commutator cleaned and polished while in service, it is necessary only occasionally to hold a pad of dry canvas against the revolving surface.

407. The roundabout spacing of commutator brushes should be symmetrical. If the spacing is irregular—if two contiguous rows of brushes are closer to each other than are two other contiguous rows—the armature circuits will be unbalanced, and heating of the commutator and sparking of the brushes will result. Brushes should be staggered; that is, they should be so distributed that the commutator will be subjected to their wear from end to end.

408. The commutators on some older machines often show a series of narrow ridges, as a result of corresponding brushes in the different rows' being aligned exactly in the same circles of contact.

409. When it is necessary to put new brushes in the holders, they should be fitted to the curvature of the commutator. It is not good practice to leave the brushes flat-ended and depend upon the wear of service to give them the necessary concavity. The contact end of a brush may be given the proper shape by inserting a strip of moderately coarse sandpaper between the brush and commutator and pulling the strip in the direction of the commutator's rotation. This operation should be repeated until enough of the brush material has been ground off to give the needed curvature. The strip of sandpaper should not be pulled back and forth, because in doing so the edges of the brush may be rounded off.

410. Sandpapering the commutator while the generator is running is practiced by many operating men. Generally, the idea of such sandpapering is to reduce sparking. The sparking may thus be abated for a time, but it is likely to recur later on in a manner more acute than before. The particles of copper and grit liberated during the sanding process will tend to lodge beneath the brushes; and the smoothed-up commutator surface will be roughened once more, perhaps worse than it was in the first place. When it is necessary to sandpaper a commutator, the generator should be disconnected from the line, and the brushes raised. And when the job is done, all traces of copper dust and fine sand should be blown and wiped away.

411. The mica insulation between the commutator segments should be undercut, because, if it projects but slightly, the brushes will be cut away in a short time. But discretion must be exercised in doing the undercutting; if too much of the mica is removed, cavities will be left for accumulations of copper and carbon dust, mixed, perhaps, with grease deposited by an oily vapor in the surrounding atmosphere. Thus the commutator bars may become short-circuited. In any event, serious sparking is sure to result from such deposits between the segments.

Chicago, Ill. D. J. ALLISON.

412. Faulty Commutator Caused Armature Failure.

An armature of a generator was brought to our shop for repair. Examination showed that most of the coils were damaged and a new winding was necessary. After removing the coils and cleaning the commutator, we tested it and found it in seemingly good condition. When rewinding was completed, insulation resistance was tested with a megohm meter, which indicated about 15 megohms.

The armature was put into an oven and heated prior to varnishing, and when it was fairly hot another insulation test was made. This time the insulation resistance was 10,000 ohms only. When the heat was switched off and the armature began to cool, insulation resistance increased and at the end of an hour reached about 1 megohm. Applying heat again caused the insulation resistance to decrease.

One of the coils was suspected of being faulty. All of the leads were disconnected from the commutator, but none of the coils tested less than 20 megohms. The commutator bars were cleaned, and their ends were varnished. This time the armature was put into the drying oven without connecting the coils to the commutator. After an hour's heating, the insulation resistance of two adjacent bars was found to be breaking down to the shaft. When we removed the commutator we found a hole burned in the mica ring, with bits of copper trapped in it. The commutator was repaired and stood the test when heated, after which winding of the armature was completed. The armature was installed in the machine and operates satisfactorily.

Nagpur, India. F. C. BULSARA.

413. Flashover Troubles Corrected on Rotary-converter Commutator.

We have a 500-kw. rotary converter that has always been sensitive to power-supply disturbances. It finally became so bad that the commutator would flashover sometimes two and three times a day, with the usual damage to the brushes, rings and commutator.

Our first effort to correct the trouble was to give the entire machine a thorough cleaning. This machine is equipped with a full set of asbestos-board flash barriers, and considerable copper was scraped off these where it had been embedded by the flashes. It was also found that the pilot brushes were too soft and tended to shatter. These were replaced with a harder grade, and the trouble was partially eliminated, but it started all over again in about four days.

A 1,500-volt, 1-microfarad lighting arrester of the condenser type was obtained and connected in series with a 10-amp., 600-volt fuse directly across the commutator. The flashover trouble stopped, but the factory insulation between the commutator bars and clamping ring was so badly burned that it was decided to lengthen the path to ground and reinsulate the ring in one job.

A wooden ring was turned in four sections, as shown by the dotted lines (left, Fig. 134), to match the steel clamping ring. The material was 1-in. well-seasoned oak. Four sections were used to obtain strength in cross section. On large commutators, 15 or 20 sections might be required. Each piece was drilled with three holes and countersunk ⅜ in. for ¼-in. flathead machine screws. Slight errors in the drilling made it impractical to have these pieces interchangeable, so we simply drilled and tapped the steel clamping ring to fit and fastened each piece in place before marking off the next one.

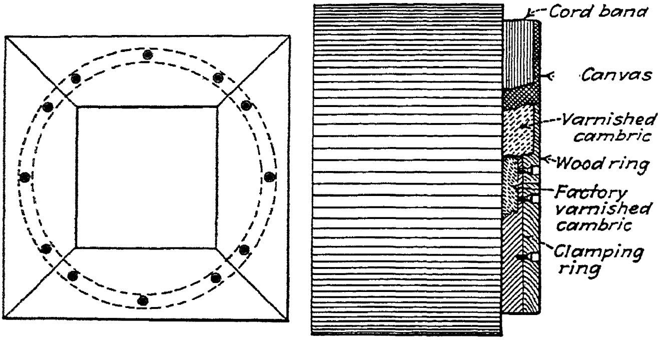


FIG. 134.—Left, dotted lines show how wood ring was made; right, insulation arrangement on commutator and clamping ring.

Pieces of canvas were clamped between the wood and steel rings, with the canvas hanging toward the center of the rings. After all screws were tightened, a coat of shellac was applied to the outside surface of the rings. While this was sticky, varnished cambric tape was wound around, covering both rings until sufficient insulation was in place to equal that put on in the factory.

Another coat of shellac was applied; then the canvas was brought around the edge of the ring and tied temporarily with a cord (right, Fig. 134). The cord band held the canvas in place while all wrinkles were drawn out to make a smooth job.

Then, starting at the outside edge, a permanent cord band was put in place over the canvas.

Two thin coats of shellac were applied, then one thick one, after which the exposed canvas was ironed out with a hot soldering iron to harden it in order to prevent slinging of shellac. About two days later, the first coat of red oilproof insulating cement was applied. The second coat was given the next day, and when it had dried the machine was started. We have had practically no flashover trouble since revamping this ring, and the insulation is still in good shape.

Nashville, Tenn. THOMAS E. MILLER.

414. Pulley Out of Balance Causes Sparking at Brushes.

A 50-kw. direct-current generator gave trouble from sparking at the brushes. All the usual means of correcting were tried without success. These included truing the commutator surface with a stone, adjusting the brushes, changing the brushes, checking polarity of field coils and undercutting the commutator mica. As a last resort, a new foundation was built for the machine, but this did not improve conditions much.

By this time, the commutator was not in very good condition. The armature was taken out and sent to a machine shop to have the commutator turned in a lathe. As the pulley was found difficult to remove, it was left in place. When the armature was in the lathe it was discovered that the pulley ran about 0.1 in. out of round.

The commutator was conditioned, and the pulley turned round. Since then no trouble has been experienced with sparking at the brushes. Apparently, the pulley was out of balance sufficiently to cause the armature to vibrate and the brushes to chatter and spark.

Cleveland, Ohio. C. O. PERKINS.

415–418. Four Pointers on Maintaining Brushes on Rotary Converters.

415. We have found it good operating practice to keep a close check on the brushes of our rotary converters, especially those on the slip rings. We are using soft graphite and copper brushes, which expand considerably if overloaded and are likely to stick in the holders and throw more load on brushes still free. In a short time there will be a damaged ring. Unless attended to, a flashover may occur. At our automatic stations, one or two carbon brushes are used in each group of ring brushes, as these are not so likely to stick in the holders as the graphite-copper brushes.

416. When replacing brushes, we do not sandpaper them to the shape of the ring or commutator surface but add one or not more than two in each group of brushes at one time. They wear in perfectly in a few days. To sandpaper the brushes to a fit on the direct-current end would be a real job, for the commutator is covered with flash barriers that would have to be removed.

417. Soft alternating-current brushes wear considerably, and the resulting metallic dust is removed frequently from all the insulating surfaces and from the inside of the brush holders.

418. On direct-current pilot brushes, it has been found that flashing when starting can be relieved considerably by reducing brush thickness so that it cannot bridge more than two bars at once.

Nashville, Tenn. THOMAS E. MILLER.

419. Reducing Wear on Slip Rings and Brushes.

The slip rings of alternating-current generators and motors often wear unduly because of abrasive grit, derived partly from the wear on the rings and the brushes and partly from the atmosphere's getting between the brushes and the rings. As this

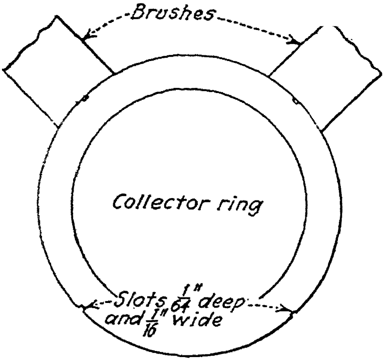


FIG. 135.—Grooves in face of slip ring collect grit and keep it from working into brushes.

grit has no means of escape except across the face of the ring, it tends to work into brushes.

This trouble can largely be prevented by cutting four shallow, narrow grooves around the face of the slip ring, as shown in Fig. 135.

These grooves can be made with a hack saw. They should be about 1/64 in. deep, the edges being smoothed down to give a good surface. The dirt which is worn from the rings and brushes will collect in these grooves instead of under the brush face.

Brentford, England. W. E. Warner.

420. Maintaining Good Brush Contact on Slip Rings.

The working face of a slip-ring brush usually has a length of 1 in. or more. By slotting the brush in two places at right angles to the direction of rotation of the slip ring, the brush is virtually divided into three and has therefore three leading edges instead of one. In this manner, the scouring action of the brush is increased and helps to maintain good contact with the ring. The slots are made by dividing the contact face of the brush into three equal lengths and cutting the slots 3/8 in. deep, as in Fig. 136, with an ordinary hack-saw blade.

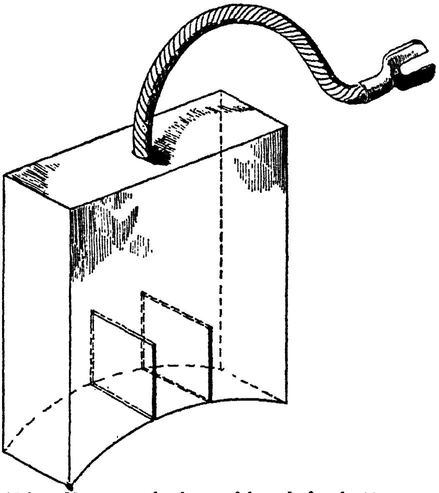


Fig. 136.—Slots cut in face of brush for better contact.

Entre Rio, Argentina. C. A. H. MacDonald.

421. Dust on Slip Rings Causes Single-phase Operation.

An instance of single-phase operation of a three-phase motor may be of interest. The motor was of the wound-rotor slip-ring type with the rings uncovered, driving an air compressor in a very dirty place. Dirt collected on the rings and brushes and caused them to break contact. The effect on the service was severe. The feeder ammeters indicated unbalancing with violent pulsations that caused objectionable flickering of lights. Placing a dustproof housing over the slip rings solved the difficulty.

Brooklyn, N. Y. C. O. von Dannenberg.

422. Slip-ring Treatment against Chlorine Gas.

A phase-wound motor gave trouble owing to heating and flat spots on the slip rings. The cause was a slight amount of chlorine from one of the processes, which caused a thin film of copper chloride, of comparatively high resistance, to form on ring surfaces.

As the motor could not be properly protected from the fumes, brushes were installed that were slightly abrasive, to clean the surface of the rings. A piece of paraffin was applied to the rings shortly before stopping. This formed a protective film.

Hertfordshire, England. W. E. Warner.

423. Testing Laminated Brush Contact.

To test the efficiency of contact between laminated brushes and a solid contact, cover the contact with tin foil and close the circuit breaker. Then open it immediately and examine the tin foil. When the fit between the laminated and solid contacts is good, the tin foil will be marked with parallel lines where the laminations bear. If the pressure is excessive at any point, the tin foil will be cut through. When the laminations do not bear at any point, the tin foil will not be marked. Laminations can be trimmed up with a fine file until a good fit is obtained.

Hertfordshire, England. W. E. Warner.

424. Rotor Unbalance Caused Flat Spots on Slip Rings.

In one alternator, flat spots were continually developing. Regrinding provided only a temporary solution. The cause was finally traced to unbalance.

To remedy the trouble, the rotor was rebalanced, and then the rings reground at working speed. During regrinding, more metal was removed from some parts of the ring than others, showing that the previous surface was not true. There was no further trouble with flat spots, showing that unbalance was the cause of the trouble.

Hertfordshire, England. W. E. WARNER.

425. Testing Wave-wound Armatures.

A device useful for testing wave-wound armatures is made from a strip of sheet fiber about 2 in. wide and long enough to reach more than halfway around the commutator. A slot is cut in this as shown in Fig. 137. Two contact points are held in the slots by nuts and are connected to a millivoltmeter.

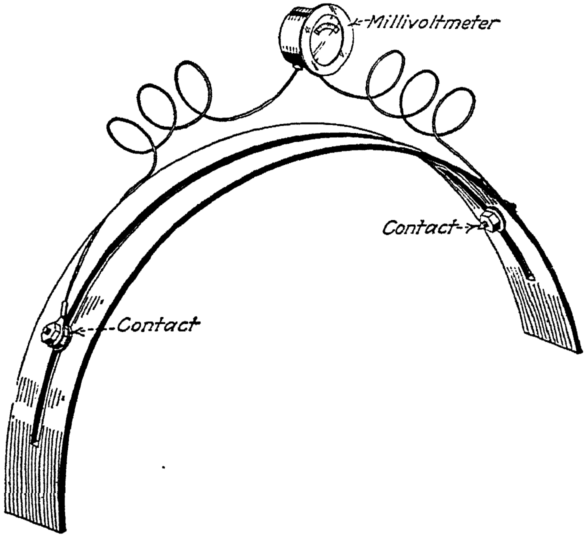


FIG. 137.—Contacts are held in a fiber strip.

When testing, the correct segments are first located, and the two contacts adjusted to bear on them. As the pitch of the coils will not vary, the contacts when once fixed will be correct for other segments. The armature can then be tested without further trouble in locating segments, as those on which the contacts bear will always be connected to the same coil. The strip can easily be bent to the radius of the commutator.

Brighton, England. W. E. WARNER.

426. Testing for a Reverse Coil in a Stator Winding.

A method that I have used to locate reverse coils in a stator winding of a three-phase motor may be of interest. I have a portable ammeter with a split-core type current transformer. If the conductor in which the current is to be measured is wrapped several times around the transformer core, a small current flowing in the conductor can be made to give a large reading on the meter. I have taken advantage of this to test for reverse coils in induction-motor windings.

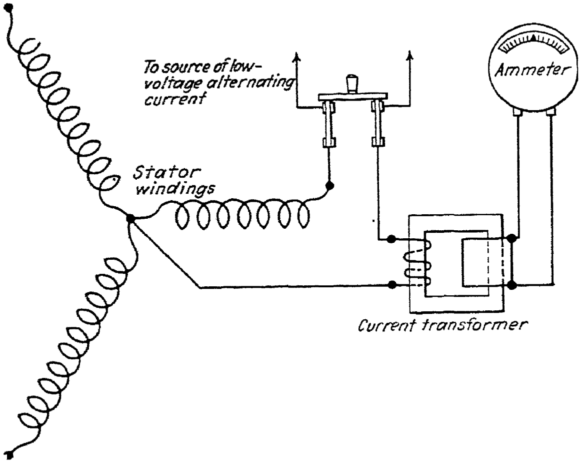


FIG. 138.—Transformer connections for testing.

The transformer is connected to one phase winding of the motor and to a source of low-voltage alternating-current, as in Fig. 138. A reading is taken on this winding; then the switch is opened, the power lead moved to another terminal of the winding, and a reading taken on another phase. If the phase windings are alike, then the ammeter should read the same on all of them. If a coil is reversed in one winding, then the reading on this winding will be high. By breaking up the high-reading phase into pole groups and testing each group separately, I can locate the group having the reversed coil by a high reading.

In a 15-hp., 440-volt motor, I found that when a pole-phase group of four coils properly connected gave a meter reading of 100, one coil reversed increased the reading to 150. I have tried other methods, but none has been so satisfactory.

A short-circuited coil in a group will produce the same effect on the meter, but this coil heats more than others when the winding is connected to a source of power. When a coil is reversed in a winding, all coils will heat alike. It should also be kept in mind that in some windings the coil groups do not all have the same number of coils, and this must be taken into consideration when making the test.

Lomita, Calif. C. H. FENTON.

427-428. Two Ways of Preventing High Induced Voltages from Motor Field Coils.

Many of the older types of elevator controllers were arranged to kill the field each time that the motor was stopped. The field winding was connected into the control in such a way that, when the motor was disconnected, the field discharge was taken through the armature.

It not infrequently happened that, owing to wear of the control parts, misadjustment, or the way that the control was handled by the operator, the field circuit would be opened when the motor was stopped. Then the fun started; the insulation began to fail in various places.

427. There are two ways in which this trouble can be permanently eliminated. One is to connect a comparatively high resistance across the field-coil terminals. This resistance may consist of a resistance tube of the proper capacity, or, as is frequently done, a lamp bank may be used. Four or six lamps of the rated voltage of the motor may be connected two in series, and the groups connected in parallel to the field-coil terminals. In case the field circuit happens to be opened, the discharge is taken care of through the resistance, and the induced voltage is maintained at near normal line value.

428. A second method for preventing the field-coils' circuit being opened and the motor subjected to a high induced voltage is to connect the field coil permanently across the line. This is the way the field coils are connected on most modern elevators that are in constant use. This method has the advantage that the field poles are excited before the armature is made alive, and the motor will develop a higher torque at the instant of starting than when the field has to build up during the starting period. This has allowed the use of shunt-type motors for applications that originally used compound types. Where an elevator is used infrequently, the motor field coils should not be connected permanently across the line: first, on account of the increased power consumption; second, unless the coils are liberally designed, they may roast out if the motor is left idle for long periods.

Cleveland, Ohio. C. O. MILLS.

429-433. Five Ways of Preventing Vibration in Motors.

Vibration in motors is not uncommon and may be the cause of breakdowns in the windings, as it will tend to loosen the connections and injure the insulation. Brush chattering may result, and in high-speed machines the brushes may be chipped and broken.

429. Vibration may be due to a defect in the motor itself or may be transmitted from the connected load. An armature out of balance, electrically or mechanically, may be the cause. As the manufacturers make tests at their works, these faults should be detected by them. A bad surface or an eccentric commutator will create vibration at the brushes, which increases as the speed rises. Too much play in the bearings may also be the cause. An unequal air gap between the pole pieces and armature will cause an unequal magnetic pull by the different field poles, which will increase the wear at the bearings and may produce vibration.

430. The origin of vibration in an induction motor with a squirrel-cage rotor was found to be several high-resistance joints in the rotor circuit. These caused the rotor to be electrically unbalanced. When the defective joints were located and repaired, the vibration disappeared.

431. Vibration may also be produced by poor joints in the driving belt, which gives a jolt each time a joint passes round the motor pulley. Where the motor is connected to its load by a chain drive, if this is poorly lubricated or improperly adjusted, it will vibrate when running. Where the motor is connected by gearing, a flexible coupling should be used, as gears cause considerable vibration, especially if not properly lined up and lubricated. Where the motor is direct-coupled to its load, if it is at all vibrating, a flexible coupling should be used.

432. Insecure foundations or loose holding-down bolts are also possible causes. The whole machine may vibrate owing to the vibration of its foundations; a remedy for this is increasing the weight on the bedplate. In one instance, vibration was materially reduced by placing two 112-lb. weights on each side of the bedplate. Afterward, a layer of lead was run into the bedplate, and this cured the trouble.

433. In many armatures, it is the practice to use fiber spacer blocks between the coils. These blocks are secured by rivets. I have known cases where vibration has caused these blocks to become loose. In one instance, one of these blocks fell out and was carried between the armature and field coils. This damaged the insulation on all the armature coils and made rewinding necessary. The cost of this was many times greater than a flexible coupling which, if it had been fitted, would have damped out the vibration.

Brentford, England. W. E. WARNER.

434. Induction-motor Rotor Pulled toward One Bearing.

The rotor on a three-phase motor would pull endwise until the shoulder on the shaft was held tightly against one of the bearings, when it should have taken a position clear of each bearing. With the current off, the rotor would ease back until the shoulder on the shaft was away from the bearing.

The electrician in charge was puzzled over this action and thought that the motor might not be properly leveled. Upon checking, the side toward which the rotor pulled was found to be a fraction low. This was corrected, but the rotor's action remained the same as before. Some one suggested that the motor pulley might not be in line with the driven pulley and that the belt was responsible, but the rotor acted the same with the belt off.

It was finally determined that the laminations in the rotor did not line exactly with the laminations in the stator when the rotor was in central position between the bearings. A press was available, and after careful measurements the rotor was taken to the press and pressed over on the shaft until it would center with the stator. When reassembled, the rotor floated properly and operated as it should.

Cleveland, Ohio. M. A. DOUGLAS.

435-436. Two Causes of No-voltage Coil Overheating.

435. A solenoid coil on the no-voltage release of an alternating-current motor starter burned out. A second coil also burned out after a short time. A third coil was fitted, but when connected to the line, it also overheated.

The coil and trip gear were dismantled, and it was found that the movable iron core was attached to a thin brass stem on which there was a spiral spring. This spring performed no useful duty but evidently had been inserted after the starter was put into service. The spring acted as a short-circuited secondary to the coil and had a current induced in it similar to the secondary circuit of a standard alternating-current transformer.

In an alternating-current coil, current is limited by the ohmic resistance and the induced voltage in the coil. Induced voltage in the coil is determined by the magnetic field in the coil and the frequency of the current. Current flowing in a secondary coil is in opposition to the primary current and tends to weaken the magnetic field and decrease the induced volts in the primary coil. As a result the current increases in the primary coil. This is one of the explanations for the heating of the no-voltage release coil. Current flowing in the spring caused the current in the solenoid coil to increase.

436. The spring also prevented the core from pulling all the way up in the coil. This increased the air gap in the magnetic circuit, which caused a decrease in the magnetic field and of the induced voltage in the coil. As a consequence of this, the current was increased in the no-voltage release coil. The combination of these two effects increases the current sufficiently to burn out the coil.

The starter was a fairly old one, and the spring may have been inserted by some maintenance man to insure a good fit. The spring was removed, and the space between the core and the brass spindle was packed with a leather washer, after which the coil was found to run quite cool.

Brentford, England. W. E. WARNER.

437. Why Voltage Varied on the Exciter.

A 10-kw., 125-volt exciter, which had been belt-driven, was direct connected to an alternating-current motor which had just been rewound by an outside repair shop.

The exciter was taken apart, cleaned and painted, connections were cleaned and tightened, and new bearings were installed. The motor to which it was to be direct connected operated at a speed 300 r.p.m. faster than the exciter, so holes were drilled in the main field poles to compensate for the increased speed.

When the unit was put into service it ran satisfactorily, at times. And again the exciter voltage would vary from one-half to full voltage. It was so sensitive that walking on the suspended platform seemed to start the voltage varying.

The exciter appeared to be in good condition. Finally we suspected that something was wrong with the driving motor instead. The repair company again checked over the exciter and the motor winding without finding any cause for trouble. They then put an ammeter in the motor circuit, and this soon indicated that the trouble was in the motor. Inspection of the motor rotor revealed several loose bars. When these had been welded, the unit operated perfectly.

Niagara Falls, N. Y. MARIN PHILLIPS.

438-440. Three Aids in Preventing Ground-clamp Overheating.

438. The single-conductor lead-covered cables leading from a 10,000-kva. alternator to its oil switch had their sheaths grounded. Connections to the ground cable were made by two-piece iron clamps bolted to the lead sheath. Shortly after the generator went into service, the ground-clamp temperature was discovered to be dangerously high. This was due to the large eddy currents induced in the clamps by the heavy magnetic field set up in the iron around the cable. Making one-half of each clamp of brass and using brass bolts instead of iron corrected the trouble.

439. Trouble of this kind is not uncommon with alternating current. Single conductors must not be inclosed in iron conduit. All the phase leads should be in one conduit so that the magnetic fields of the different conductors neutralize one another. There will then be no trouble due to eddy currents unless a fault occurs on one phase, which upsets the electrical balance between the phases. The out-of-balance current will tend to produce eddy current in the iron conduit.

440. In some makes of switchgear, the castings connecting the conductor sheaths to the switch are in halves, one being made of iron; the other of brass or aluminum. This prevents heavy eddy currents' being induced in the casting. When searching for trouble on alternating-current systems, the possibility of eddy currents should not be overlooked, and iron parts surrounding conductors should be watched for heating.

Brentford, England. W. E. Warner.

441. Why Polarity of Exciter Becomes Reversed.

A trouble sometimes encountered when running alternating-current generators occurs through the exciter's reversing its polarity. This trouble is most frequent where the exciter armature and field cores are laminated and the generator field cores are solid.

In these cases, the current in the exciter armature will die down more quickly than the current in the generator field circuit. This may be the cause of a reverse current through the exciter armature, which may demagnetize or reverse the polarity of its field. This usually happens when the main breaker comes out and the exciter field is quickly opened to prevent an undue voltage rise on the generator. In these cases, the inductive discharge from the generator field may reverse the direction of current flow through the exciter armature and demagnetize or reverse the polarity of its field. If, before opening the exciter field switch, the resistance in the field is quickly cut down, the possibility of this trouble will be greatly reduced.

Making rapid changes to the exciter field is at all times inadvisable. When an exciter reverses its polarity, the British Engine and Boiler Insurance Co. recommends the following method of restoring the polarity: Run the setup, magnetize the main field, and rapidly break the exciter field circuit. Running the set up and putting in the field resistance at a rapid rate will often reverse the polarity of the field.

Brighton, England. E. W. Wilson.

442. Motor Failed to Operate at Synchronous Speed.

When putting a synchronous motor into service for the first time it was found that it would no sooner pull into synchronism than it would drop out again and take a heavy lagging current from the line which would cause the oil switch to trip out. It was also observed that the shunt exciter sometimes apparently lost its voltage when the trouble occurred.

We found that the two terminal connections on the field coils were made in such a way that they could be easily pushed together to short-circuit these coils. When the motor reached synchronous speed the centrifugal force acting on the field-coil terminals was sufficient to bring them together and short-circuit the entire group of field coils. This would cause the motor to drop out of synchronism and take a large lagging current.

Philadelphia, Pa. CHARLES A. ARMSTRONG.

443. Protecting Coil Ends in Induction Motors.

After rewinding a 400-hp., 2,300-volt induction motor, it was discovered that the winder had injured the insulation on the ends of a number of the coils when driving the wedges into the slots. To prevent this from occurring when rewinding other machines, after the coils were all in place and before driving in the wedges, strips of canvas were cut and placed over the coil ends. These strips were wide enough to extend from the core out over the end of the coils. The canvas was painted lightly on the side placed next to the coil ends. With the canvas over the coils, if the winder happened to make a slip with the hammer and hit the coil ends, the canvas protected the insulation from injury yet could be removed afterward.

Butte, Mont. RALPH E. MACKAY.

444. Two Motors Drive the Same Load.

In a rock-crushing plant, a larger crusher had replaced a smaller one. The crusher was driven by a 150-hp., 900-r.p.m., three-phase motor through a countershaft. Test showed this motor was overloaded 25 per cent a greater part of the time. A spare motor was rated at 50 hp., 900 r.p.m., three phases. A shaft extension was added to the larger motor by using a solid coupling and an outboard bearing. A 12-in. pulley was placed on the 50-hp. motor's shaft, and the same size on the shaft extension of the 150-hp. motor.

After starting it was found that the small motor was running at nearly the same temperature as was the large one before the change. A wattmeter test showed that the 50-hp. motor was overloaded 12 per cent. The 12-in. pulley on the 50-hp. motor was then replaced by one 11.5 in. in diameter.

Tests were then made, and both machines were found to be operating normally with a decrease in temperature and line current. Satisfactory results followed until the close of the plant.

Seattle, Wash. RALPH E. MACKAY.

445. Why the Motor Winding Burned Out.

A 20-hp., three-phase, delta-wound squirrel-cage motor was started by a star-delta switch and protected by a circuit breaker fitted with a no-voltage coil and two overload coils, the trips being set to operate at 120 per cent overload without a time lag. It suddenly stopped. One phase winding was found burned out owing to an open circuit in the starter. This had caused the motor to run as a single-phase machine, one winding working in parallel with the other two in series.

In a delta-wound machine of this size, the current passing through the phase winding connected singly across the line would be about twice full-load current. This would be insufficient to operate the circuit breaker, set at 120 per cent overload.

To guard against accidents of this sort the circuit breaker should be set to operate when full-load current is exceeded by 25 per cent or more.

If the breaker were set so close, it would open each time the motor was started, as well as during momentary overloads. This could be prevented by suitable time lags. An alternate method is to arrange for the circuit breaker to be in circuit only while the motor is running. During starting, the motor is protected by fuses, arrangements being made to cut them out of circuit when the motor reaches full speed.

Brighton, England. W. E. WARNER.

446. Interchange Bearing on Motor to Keep Machine in Service.

A 15-hp. induction motor belted to an induced-draft fan blew its fuses. Examination of the motor showed the bearing on the pulley end worn so that it allowed the rotor to rub on the stator core, and that this was the cause of the blown fuses.

The motor had to be put back into service as soon as possible. As a new bearing was not available, we decided to interchange the two bearings in their housings. This put the good bearing at the pulley.

The motor was started, and operated thus for two months.

Toronto, Ont. L. W. Ross.

447. How Pump Motor Was Kept in Service.

An operator of a process pump reported that the motor had stalled. This was a 5-hp. unit with roller bearings. Everything checked all right, including the rotor. The bearings were practically worn out, but the rotor was not rubbing the stator. As the pump was needed badly, and it would be several days before new bearings could be obtained, a temporary repair had to be made. Taking up wear in these bearings is accomplished by removing laminated shims between the faces of the bearing housing and the end bell of the motor. All of these shims had been removed.

A washer was cut out of 20-gage iron the same size as the bearing thrust. It was placed against the bearing, and the housing bolted up tight. The motor was started and operated satisfactorily.

If a more permanent repair had been desired, the bearing housing could have been turned off about $\frac{1}{16}$ in. on the finished face. This would have answered the same purpose as the washer. Of course, when new bearings were installed it would have been necessary to shim up for the amount of metal removed.

This method would not be recommended for a permanent repair.

Tarrant, Ala. G. H. Emerson.

448. Flexible Wire Best for Shunt-field Connections in Direct-current Machines.

Numerous cases of trouble have been encountered on direct-current machines from shunt-field leads breaking or burning open. Most of this trouble is caused by having solid wire in the leads connecting the field coils with the outside terminals. The solid wire is too rigid to withstand vibration. I have used a flexible wire twice the size of the original lead. This eliminates all trouble from broken connections.

Butte, Mont. Ralph E. MacKay.

449. Control Battery Used for Emergency Lighting.

A substation shut down for four hours to do several repair jobs. All power was cut off from the station, when it was discovered that making the station dead also cut out the lighting system. Normally, lighting was supplied from a 15-kva. 4,000- to 110- and 220-volt transformer. In the substation, there was a 110-volt control storage battery, and it was connected to the lighting circuit as in Fig. 139.

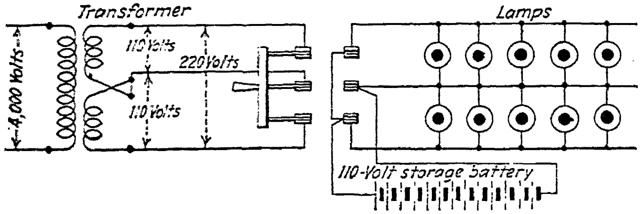


FIG. 139.—Storage battery for 110 volts connected to lighting system.

Butte, Mont. RALPH E. MACKAY.

450. Connecting Three-phase Motors in Series.

We use three-phase, 440-volt alternating current. We had two 8-hp. motors which ran together on a certain machine. These motors were wound for 220 volts and could not be used on a 440-volt circuit without rewinding. We ran the motors for a while with a transformer, but the transformer was needed elsewhere, and the question of adapting these for 440 volts was again brought to mind. Figure 140 shows how the two motors were

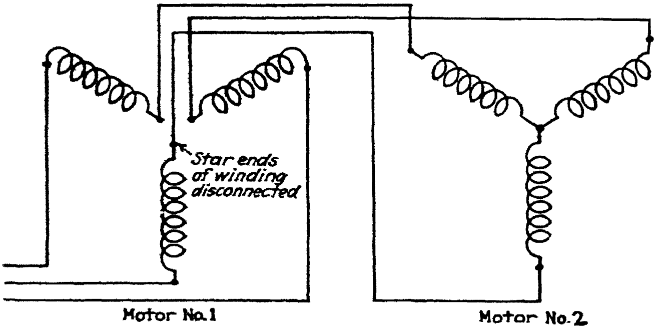


FIG. 140.—Two 220-volt motors connected in series for 440-volt operation.

interconnected to run on 440 volts. A simple rule for doing this is:

Disconnect the star ends of the winding on one motor and connect them to the terminals of the second motor. If the second motor does not run in the right direction, simply transpose any two wires between the two.

Butler, Tenn. W. S. Whiting, Jr.

451. Motor Test Discloses Single-phase Operation.

Single-phase operation of a group of motors on a polyphase circuit sometimes escapes the attention of maintenance men. As an example, a blown fuse of 400-amp. capacity on a three-phase feeder was not found until a regular routine motor test was made on one motor—the voltage and ampere readings of which were found unbalanced.

The process was continuous, and two 50-hp. and two 25-hp. motors were connected to the circuit. The circuit was checked, and when the fuses on the feeder were tested one was found blown. None of the motors was fully loaded, which prevented them from being seriously overheated. At no time were they all shut down; consequently any one could be stopped and started again because the running motors acted as phase converters and provided three-phase power.

Such a condition of single-phase operation may be guarded against by watching for overheated motors on any feeder group, by regular testing of feeder fuses, by routine motor tests, and by regular tests of voltage on each feeder to detect unbalanced voltage.

Alcoa, Tenn. J. Elmer Housley.

452. Changes Two Motors and Saves $2,400 per Year.

We have 120 squirrel-cage induction motors operating at various speeds and in sizes ranging from 1 to 50 hp. As a result of some motors' being lightly loaded, plant-load power factor was low. In an effort to improve power factor and operating conditions and to reduce power costs, it was decided to improve loading on some of the motors.

A 50-hp., 900-r.p.m. motor driving a line shaft was found to be loaded only to about 18 hp. and was replaced by one rated at 20 hp. and 1,200 r.p.m. that was available as a spare. Another

50-hp., 1,800-r.p.m. motor driving a blower was replaced by four 3-hp. and one 5-hp., 3,600-r.p.m. motors, all driving blowers, that were purchased second hand. After the changes were made, the power bill dropped about $200 per month. Of this saving, about $80 was a reduction in demand and $120 in kilowatt-hour charges. The total cost for making the change was $545; consequently, the saving in power costs will pay for replacing the motors in about three months.

Chicago, Ill. E. F. Carlsen.

453. Loose Motor Connection Causes Light to Flicker.

A three-phase alternating-current slip-ring motor connected to its load by a belt gave considerable trouble owing to conditions that should have been remedied before the machine was started. Within six months after its installation it was necessary to renew the bearings and locate the rotor central in the stator bore. This trouble was caused by misalignment of the rotor in its bearings. The next mishap occurred while the motor was running at night. Lighting circuits were taken from the same line as the power for the motor. Flickering of the lights developed, and at the same time a noticeable swing of the ammeter needle occurred.

When the motor was shut down it was tested, and a partial open circuit was found in the rotor winding where two of the phases were joined. This connection had been made by soldering four conductors into a connector, two in parallel from each of two phases. Two of the conductors from one phase had worked loose, and their ends could move in the connector. The belt had a bad joint in it, and each time it passed around the motor pulley it jarred the rotor. This shock caused the two loose ends of the winding to separate and produce a fluctuation in the current at each revolution of the belt.

Brentford, England. W. E. Warren.

454. Overheating of Rotary-converter Coils.

In a rotary converter, coils adjacent to the slip rings tend to heat more than the other coils. Current distribution in the armature is uneven, the momentary current at any point being the momentary value of the alternating current superimposed on the value of the direct current, the greatest root mean square value of the combined currents being carried by the coils connected to the slip-ring tappings. This causes these coils to be always slightly overloaded and therefore more heated than the other coils. This current is increased if the converter is operated at a lower power factor.

Where rotary converters are being operated at a low power factor, the rating of the converter should be slightly reduced; otherwise there is danger of these coils' being overheated sufficiently to burn out, while the remainder of the armature coils may not be heated dangerously high, which would probably cause the overheated coils to be unnoticed.

Brentford, England. W. W. EMERSON.

455. Method of Banding a Large Rotor.

Some time ago, I had a large rotor to band with No. 12 banding wire, which required considerable tension. The job was accomplished in the following manner: A back-geared die stock was clamped to the rotor shaft by means of a dummy die longer than the others and made to engage in the key seat. A piece of $\frac{1}{16}$-in. fiber was placed around the shaft to prevent the teeth of the dies from marring it. The follower portion of the die head was prevented from turning by means of a torque arm fastened to it. Figure 141 shows plainly the set-up.

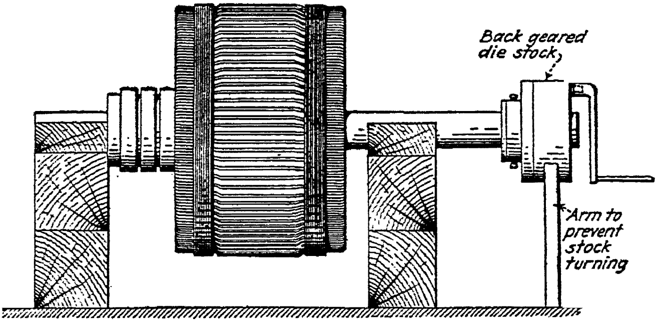


FIG. 141.—Rotor turned with a back-geared diestock.

The die stock afforded a ratio of about eight to one. In place of the usual handle a 20-in. crank was used, and the rotor banded quite easily.

New Westminster, B. C. W. L. STEVENS.

456. When Outboard Bearings?

A table published by a leading motor manufacturer gives the limit of size of two-bearing motors as 40 hp. at 1,800 r.p.m., 75 hp. at 1,200 r.p.m., and 125 hp. at 900 r.p.m. for belt drives. When chain drives are used the limits are given as 15 hp. at 1,800 r.p.m., 25 hp. at 1,200 r.p.m., and 50 hp. at 900 r.p.m.

There are two reasons for using outboard bearings on motors of smaller ratings connected to loads with chain drives. The standard sprocket diameter for a chain drive on a motor shaft is approximately one-third that of a standard pulley for a flat-belt drive. As a result, the speed of a belt under average conditions is about three times the speed of a chain drive. This requires that the pull in the chain be approximately three times that in the belt for the same output. The greater load in the chain tends to deflect the motor shaft and cause unnecessary wear of the sprocket and chain because of misalignment. With a flat belt, a small amount of misalignment does not have so serious an effect as with a chain or gear drive. Also, a chain is a positive drive; consequently load shocks are transmitted to the motor bearings more readily than with a belt drive, which can stretch or slip to relieve the peaks of the shocks.

San Antonio, Tex. R. H. Parrish,
Alamo Iron Works.

457. Check Phase Rotation When Paralleling Alternating-current Generators.

A 250-kva. waterwheel-driven generator was to be paralleled with a 1,500-kva. steam-turbine-driven unit. A temporary line was run to the main switchboard, and a paralleling switch was mounted near the waterwheel generator. Everything was placed in readiness, and lamps were used to indicate when the machines were in synchronism. At the proper moment, as indicated by the synchroscope, the paralleling switch was closed. A terrible explosion followed. Two men were painfully burned by hot oil and molten copper caused by the explosion of the paralleling oil switch.

An investigation revealed that the men doing the work had disregarded the phase rotation of the waterwheel-driven generator.

Butte, Mont. Ralph E. Mackay.

458. Restoring Dynamo's Residual Magnetism.

A pair of direct-current, compound-wound dynamos directly driven by high-speed engines were run alternate weeks. Only occasionally, and then for but brief intervals, were both of them needed to supply the load. One day the oiling system on the engine in operation failed, and it was necessary to get the other unit into service in a hurry. But when the reserve engine was brought up to speed the connected dynamo refused to generate. The pilot lamp on the switchboard flickered for an instant and went dead, while the needle of the voltmeter budged not at all.

After testing the fuses and finding everything else intact, the engineer concluded that the machine had lost its residual magnetism. But he did not know how it could have done so. During its idle period the machine had been given a limited overhauling, which consisted principally of turning up the commutator by means of a portable turning rig bolted to the field yoke.

The engineer knew that the residual magnetism of a direct-current generator can be restored, or reversed if needs be, by sending a current through the magnetizing coils from an outside source. This he proceeded to do. He lifted all the brushes from the commutator, so as to avoid short-circuiting the armature, and then he closed the equalizer and line switch. Thus he put the shunt winding of the dead machine in circuit with the bus bars and so restored the residual magnetism. Only a few seconds were consumed in accomplishing the trick. When the generator was again put in motion, after the switch had been opened and the brushes dropped back into place, the voltage promptly built up.

St. Louis, Mo. D. J. Allison.

459. Generator Polarity Reversed by Storage Battery.

A compound-wound, direct-current generator, driven by an internal-combustion engine, was employed during the day to charge a battery. But from about twilight until 10 o'clock at night the generator supplied power to the illuminating circuits. During the remainder of the night the storage battery supplied the lights.

The manner of connecting up the equipment is shown in Fig. 142. Before going off watch at night the engineer would close switch *C* and open *B*, thus isolating the battery and connecting the illuminating system to the generator. At 10 o'clock the night watchman would shut down the engine and generator, open switch *A*, and close *B*, thus putting the battery into service. The next morning the engineer would start the engine and generator, open switch *C*, and close *A* to charge the battery.

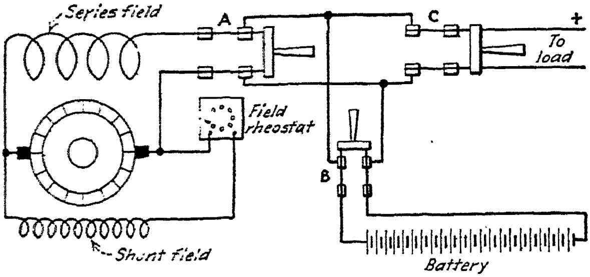


FIG. 142.—Original generator and battery connections.

When the engineer connected the battery for charging one morning, the fuses in the circuit blew out. The polarity of the generator had been reversed. The night watchman, instead of opening switch *A* before closing *B* and stopping the engine, had reversed the operation and closed *B* and opened *A* an instant later. In the brief interval between closing one switch and opening the other, a heavy reverse current flowed through the series winding and armature of the generator and reversed the polarity of the field poles.

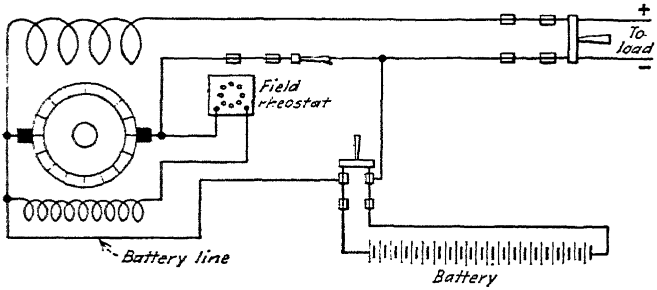


FIG. 143.—Connections to keep battery from reversing generator polarity.

To forestall all chance of the mishap's being repeated, the engineer changed the connections to those shown in Fig. 143. With this arrangement, the generator operates as a shunt machine when charging the battery and as a compound generator while supplying power to the lights.

St. Louis, Mo. A. J. Dixon.

460. Quick Repair on Generator Core.

Quick repairs were made on a 3,000-kva. 2,300-volt hydroelectric generator that had had a number of coils and its core damaged by a lightning discharge. A hole about 1½ by 4 in. was burned about halfway between the two ends of the stator core, and the laminations were welded together.

The stator was made in halves, therefore it would require a complete rewinding of one-half of the machine if the core iron were restacked to replace the damaged section. This would have been a long and expensive job, so it was decided to remove the coils around the damaged section for a width equal to the length of one lamination. After this was done, the laminations were cut down and removed until the burned section was removed.

The laminations are 30 in. long, and each is held to the stator frame by two dovetails. The laminations overlapped one-half, so that one 30-in. section could be removed whole, and the two half sections were cut off, after which another 30-in. section could be lifted out. This process was continued until the hole extended below the damaged laminations. The ends of the lamination at the two sides of the hole were carefully filed to a smooth surface, which was then painted. The hole was then stacked full of 30-in. laminations. New coils were used to replace the damaged one, and then the machine was reassembled.

In doing the job this way, it was figured that about 300 man-hours of labor were saved, besides the cost of the additional material that would have been required to rewind one-half of the machine completely.

The machine has been in service for two years with entire satisfaction since the repair was made, each lamination being held to the core by two dovetails securely anchoring the renewed section to the frame. Furthermore, the new section is anchored into the core like the keystone in an arch. The two joints between the replaced sections and the original core, if properly made, will have but little effect on the magnetic characteristics of the machine. They should be as good magnetically as the joints between the halves of the core.

Wisconsin Rapids, Wis. E. E. Belter.

461. Paralleling an Alternating-current Generator without Synchronizing.

One day in an industrial plant, the engineer suddenly noticed that power demand had crept up close to the maximum contracted for and knew that shortly the load would be increased about 100 hp.

The increase would last for only about a week, when load would drop back. It was therefore desirable to keep the purchased power demand within the contract limit.

A 150-kw. alternating-current turbine generator had supplied power before large additions were made to processes and the plant went over to purchased power. This unit had been kept in running condition to operate the pulverized-coal plant and furnaces in case outside power supply failed. To do this it was necessary only to trip the breaker on the incoming power line and close the turbine-generator switch.

If the 150-kw. turbine generator could be paralleled with the incoming power, the increased load could be handled without exceeding maximum demand. No means was available to show when the generator was in synchronism with the incoming power, and the engineer did not have time to rig up temporary synchronizing lamps.

The turbine was started and brought close to full speed, without exciting current on the generator field coils. Steam was then shut off, and the switch closed, connecting the generator to the busbars, which then operated as an induction motor. Next, excitation was applied to the generator field coils, and the machine pulled into synchronism and operated as a synchronous motor. Then the throttle valve was opened, thus changing the equipment to a generator to carry part of the load.

Moline, Ill. George P. Pearce.

462. Paralleling a Turbine Generator with a Motor Generator.

Figure 144 shows how to determine graphically the kilowatt load and power factor for any given capacity generator or transformer. Select a convenient scale for the capacity of the generators—in this case, 225 kva., the combined capacity of the two units given. Lay off the total capacity in kilowatts, to the selected scale, on the base line. With *O* as a center, draw a quadrant equal to the capacity of the units at 100 per cent power factor. Using a convenient scale and angle, draw line *OY*, having 100 divisions. Draw the line *YR*. Then, draw lines through nine divisions on *OY*, all parallel to *YR*. These lines are power-factor lines. The base line shows kilowatts, and the vertical scale gives lagging kilovolt-amperes.

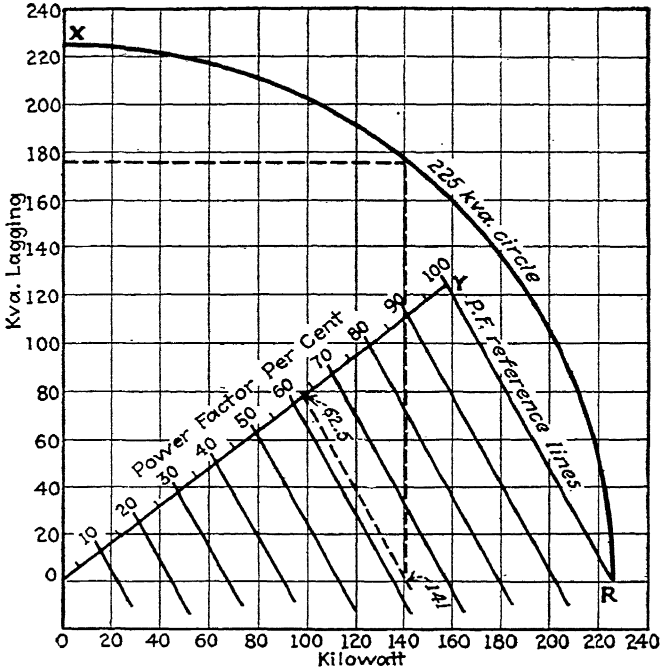


FIG. 144.—Chart for solving alternating-current generator load problems.

For the given problem of the two units rated at 100 and 125 kva., respectively, the chart shows that when both are operating as generators at full rated kilovolt-amperes, they will supply about 141-kw. load at 62.5 per cent power factor. To obtain the solution to the problem on the chart, from the 62.5 per cent point on the power-factor line *OY*, lay a straightedge parallel to the power-factor reference line *YR* and read 141 kw. where the straightedge intersects the base line *OR*. From this point (141) on the base line run vertically to the circle and from this intersection follow horizontally to the left as indicated by the dotted lines; read the lagging kilovolt-amperes on the vertical scale. The lagging kilovolt-amperes are about 176. This condition exists with both machines operating at the same power factor.

To find the power factor and the lagging kilovolt-amperes for full load and any given kilowatt load, assumed a load of 185 kw. Through 185 on the base line lay a straightedge parallel to the power-factor line *RY* and read the power factor, about 82 per cent, where the straightedge cuts the power-factor line *OY*. From 185 on the base line follow vertically to the circle, then horizontally to the left, and read about 128 lagging kva. on the vertical scale. This shows that at 82 per cent power factor the two machines can supply a 185-kw. load. The total kilovolt-amperes are 225 as before, and the lagging component is 128 kva. Any other combinations of load may be checked by the foregoing method.

Bay Shore, L. I. M. H. CURLEY.

463. Manual Starter Changed for Dynamic Braking Service.

When it is desired to stop a load quickly that is driven by a direct-current motor, it may be done by connecting the motor armature to a resistance, while the field coils are excited. The motor is converted into a generator and applies a retarding force to stop the load. This action is called dynamic braking. To use a motor in this way requires special connections in the controller.

A 10-hp. motor started by an ordinary manual-type control was driving a machine that did not stop quickly enough. At first, a mechanical or a magnetic brake was considered, but these were expensive and in other ways did not appear to be satisfactory. The next solution was to apply dynamic braking to the motor. This seemed to have the desired features for stopping the machine, but the motor starter was not designed for this service. It would require several weeks to obtain a new automatic starter with dynamic braking connections, and it was desired to put the motor and machine into service without a long delay. Therefore, it was decided to change the manual-type starter so that it would function in connection with dynamic braking until the proper type of controller could be obtained.

Figure 145 shows the connection used for dynamic braking. The shunt-field coils were connected so that they would be excited as long as the line switch was closed. A two-pole double-throw switch was mounted on the machine in easy reach of the operator and connected into the motor circuit as shown. A resistance with several taps was connected to the bottom of the switch. The taps were to allow selecting one that would give the right amount of resistance to be connected across the armature terminals to produce the desired dynamic braking effect.

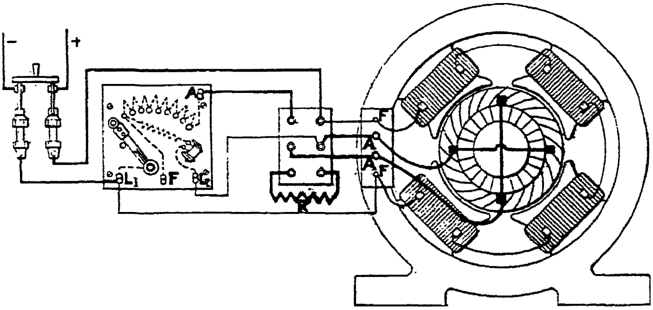


FIG. 145.—Connections used to apply dynamic braking to a motor.

With the double-throw switch closed to the up position, the motor can be started in the normal way. Throwing the switch to the down position disconnects the armature from the line and connects it to the resistance *R*, while the field coils are excited from the line. As long as the armature continues to rotate, it will have a current generated in it that will produce a braking action to bring the load to rest.

The intensity of the braking effect can be controlled by adjusting the resistance. The lower the resistance connected across the armature terminals the more severe will be the braking effect. The limit in braking effect is the amount of current that can flow through the motor without causing severe sparking at the brushes and the mechanical forces the machine will stand without injury.

The way the no-voltage release coil is connected to the double-pole switch makes the coil alive when the switch is in the up position and opens the coil when in the dynamic braking position.

This insures that the arm on the starter will be returned to the starting position before the double-throw switch is close to the running side. This method of stopping the motor worked satisfactorily for over two months until a new control was obtained. No doubt there are many places where a similar arrangement could be used satisfactorily in an emergency.

Niagara Falls, N. Y. MARIN PHILLIPS.

464. Three 150-hp. Motors Dried after 4-month Submersion.

During the revolutionary troubles at Central Cespedes, Cuba, the men who took over a sugar mill would not permit operators to keep the water pumped out of pits in which were three 150-hp. motors used to drive the centrifugal injection pumps. As a result, these motors were submerged for 4.5 months in dirty water 1 to 2 ft. over their tops. The motors had already operated through 13 crops and still had their original windings.

The motors were taken apart and dried out in an oven made around the muffler of a 150-hp. diesel engine. After three weeks' drying, an insulation resistance of 5 megohms was obtained. The motors were then varnished, reassembled, and put in operation. They ran the full crop without any interruption or sign of trouble.

Schenectady, N. Y. F. A. STORTZ, JR.
General Electric Co.

465. Starting Wound-rotor Motors after a Power Interruption.

Necessity for quick restoration of service to auxiliaries in a power station after an interruption is obvious, particularly service restoration to forced- and induced-draft fan motors. As these motors in many instances are variable-speed, wound-rotor type, it is necessary to limit the inrush current at starting. Protective equipment can be provided that requires the controller to be returned to the starting position after an interruption but necessitates that after an interruption each motor be started separately. Such a method entails a loss of time in getting the motor back into service and requires additional help where several motors are involved.

To overcome this in one plant where motor control was centralized, a separate resistor was added to each motor resistance.

Each resistor, during normal operation, is short-circuited by a contactor energized from a low-voltage relay connected to the primary circuit of the motor. As soon as the main breaker is closed, the voltage relay is energized, and it short-circuits the separate resistor. The motor is then started in the usual way, controlled by push button from the boiler room.

When a power interruption occurs, the emergency resistor section is automatically inserted. When power is restored, the motor starts and accelerates to its previous speed without attention from the boiler-room operator. There is a time delay in the voltage relay to allow the motor to come up to speed before the resistor section is cut out.

Brooklyn, N. Y. C. O. Van Dannenberg.

466. Improper Packing Causes Sparking on Generator Shaft.

I was called to a power plant to determine what caused sparks on the generator end of a 1,500-kva., 440-volt, 3,600-r.p.m. turbine-generator unit. The engineer was certain that the trouble was a ground or a loose connection on the rotor.

I watched the meters and could not detect anything in the way of an electrical disturbance. The machine tested clear of grounds. I noticed a dark-blue color on the shaft and saw that the casing was rubbing. Upon removing the casing, I found that a weatherproof wire had been flattened between the casing and the frame. The wire had served its purpose until it had become partly charred by heat. It was replaced with the proper packing, and no further trouble was experienced.

Butte, Mont. Ralph E. MacKay.

467-469. Three Points in Starting 2,300-volt Motors with Autotransformers.

Autotransformers for starting motors I consider one of the most dangerous pieces of electrical equipment in use. I know of a number of cases where men have been seriously burned in explosions of autotransformers used for starting motors of 2,300 volts and above. Death was the result in some instances.

There are several much safer methods for starting such motors, namely:

1. Have the motor designed for full-voltage starting.

2. Use series reactors to keep down the starting current. These reactors may be left in the circuit or be short-circuited by a switch after the motor is up to speed.

3. For motors above 500 hp., buy machines with two-circuit windings and arrange to connect them in series for starting and multiple for running.

It is my opinion that any one of these methods is much safer for the operator. If an autotransformer starter is used, it should be fully inclosed in a steel or concrete housing amply to protect the operator from explosion.

Jersey City, N. J. C. A. KANE.

470. Frequent Starting Causes Autostarter to Overheat.

An autotransformer of the usual design is not meant to be operated more than five or six times an hour without overheating. Autotransformer-type starters should always be carefully watched for overheating, as this is a frequent cause of faults, such as breakdowns in the oil and insulation.

Overheating is often caused if the starter is used too frequently. Another cause is its being installed in a hot place in the motor house. The maker's recommendations concerning installation and frequency of operation should be observed, as different makes of autotransformers differ in this respect.

Brentford, England. W. E. WARNER.

471. Safe Value for Insulation Resistance.

Experience in testing electrical machines shows that 1 megohm per 1,000-volts of rated voltage, regardless of capacity, is a reliable rule. Insulation resistance tests should be made periodically, depending on voltage, rating, and period of idleness. High-voltage and large-capacity machines should be tested monthly. Tests should be made, however, after each extended shutdown.

Stuebenville, Ohio. JOSEPH A. SCHNEIDER.

472-473. Two Pointers on Insulation.

472. The standards of insulation resistance are the so-called code rules for minimum values published by the American Institute of Electrical Engineers and the National Electric Code. Some electrical engineers maintain a higher standard than given in these codes, but I have found that 1 megohm is a good value to use as a guide. In other words, an insulation resistance of 1 megohm is a fair minimum limit to allow on ordinary electrical apparatus. Those who maintain the 1-megohm standard find that operating results are worth far more than the effort and expense involved in making the tests.

473. The frequency of making tests cannot depend on any set rule, as local conditions will have to govern. A piece of apparatus in a damp or dirty location requires more attention than one in a clean and dry location. In conjunction with megohmmeter testing, it is a good practice on ungrounded power systems to make a daily test for grounds in order that unexpected insulation failures may be discovered. At a plant where power is 600 volts, three phase, the ground test is made with a simple layout, using a voltmeter, as shown in Fig. 146. With no ground on the system the voltmeter should read practically zero. When a ground develops on one phase the meter will read about full voltage on the other two phases. Resistance of the ground will be a factor in the voltage indicated by the voltmeter, and it may read anything from zero to full-line voltage, depending on the insulation resistance to ground.

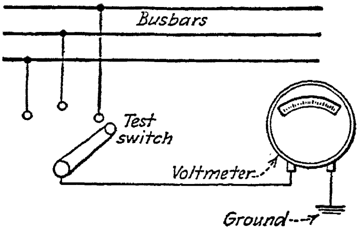


Fig. 146.—Voltmeter connected to indicate grounds on three-phase system.

Fisherville, Mass. Burton P. Robie.

474-476. Three Pointers on Restoring Oil-soaked Insulation.

474. The armature windings and field coils of motors with ring-oiled open bearings are almost sure to get oil soaked at some time, even when the oil is maintained at the proper level.

The best method to restore the insulation is to remove the armature and blow out all free dust with compressed air. A portable paint-spray gun attached to a quart jar filled with carbon tetrachloride is used to blow the liquid on to the windings. This liquid dissolves the oil and grease and removes the dirt quickly and effectively. It dries readily and is less dangerous to use than gasoline or kerosene.

475. After the carbon tetrachloride has dried, the armature is blown out again with compressed air, and the windings are wiped clean. The paint gun is filled with air-drying black insulating varnish, and the armature is given two coats of paint. The paint gun blows the insulating paint into all the openings in the windings that cannot be reached with a paintbrush.

476. The field coils are taken out of the frame and marked to keep the same polarity. The resistance of each coil is taken to determine if the windings are in good condition. After this has been done, for a distance of about 4 in. along the coil the binding tape is removed, and a layer of cotton tape is wound tightly over this space. The cutting-and-taping process is repeated until the coil has been reinsulated. A small part is done at a time in order to retain the original shape of the coil. Two layers of a good-quality friction tape are wound on the coils, and they are given two coats of air-drying insulating varnish. When the paint is dry on the armature and field coils they are assembled in the machine and given a megohmmeter test to determine the insulation resistance.

Phillipsdale, R. I. W. D. Bristow.

477-478. Two Ways of Splicing Conductors without Injuring Insulation.

The usual procedure of making splices in power wiring is to peel off the insulation and clean the wire for a sufficient length to make the splice. After making the splice, the workman usually uses a blowtorch for soldering the joint, which is heated by playing the flame directly on the splice. This heats the wire for a considerable distance back into the conduit and is likely to damage the insulation. Most wiring failures in junction boxes can be traced to this. To overcome these objections and to procure a more reliable splice, I have used two methods of making splices and have never had an insulation failure in a junction box where these splices were used.

477. On large conductors, the splice is made by soldering on terminal lugs and bolting them together, as at *A* in Fig. 147. Lock washers are placed under the nuts on the bolts to keep them from working loose.

B shows how splices are made in small wiring by twisting the ends together. The splices are soldered by raising a ladle of molten solder until the end of the splice dips into it and then lowering the ladle. In most cases, a thick coat of solder will stick to the splice, which will indicate that the splice is not hot enough. The pot is again raised and lowered until the solder runs freely off the splice, leaving a fine coating with no lumps or burs.

478. Splice *A* is easily made without damaging the insulation. It is also convenient in case a section of conduit has to be removed, as the connections can be unbolted without having to untwist the wires. When trouble develops it can be quickly located by unbolting the splices to break the circuit into sections, thus permitting each section to be tested separately.

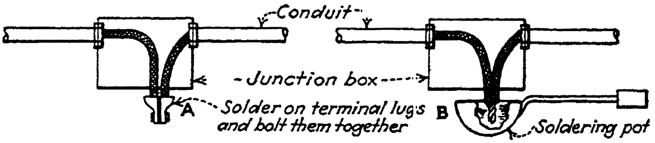


FIG. 147.—Two ways of splicing conductors without harming insulation.

Tarentum, Pa. MARIN PHILLIPS.

479. Pulling Cables through Rubber Bushings.

Sometimes rubber bushings are substituted for porcelain. Where this is done, considerable trouble may be experienced in pulling the cables through. This trouble can be eliminated by winding on one layer of varnished cambric tape, the direction of overlapping towards the direction of pull. Grease should be avoided, as it is a factor in hastening deterioration of the cable insulation.

Butte, Mont. RALPH E. MACKAY.

480. Safety Marking for Disconnect Switches.

In a fairly crowded switch room, it many times happens that disconnect switches are mounted in a continuous row, each disconnect being separated from the adjacent one by only a flash barrier.

An operator may be careless or rushed when performing a switching operation. As a result, he accidentally opens a disconnect on one phase of an adjacent oil circuit breaker, mistaking it for a switch in the line on which he has opened the oil switch. Naturally such an operation is dangerous to operator and equipment.

This danger can be practically eliminated by painting, with a bright or contrasting paint, the partition that separates the complete circuits.

Beaumont, Tex. R. F. SORRELLS.

481. Protecting Magnetic Circuits against Induced Voltages.

Difficulty with induced voltage from magnet coils was recently experienced in a pulverized-coal station. Magnetic coils were provided in a conveyor pulley to remove tramp iron. A two-pole fused knife switch in a switch box was provided to control the circuit. This box was of the bull's-eye type, with an electric light bulb serving as a pilot light to indicate when the circuit was alive. The lamp burned out frequently—we thought from vibration.

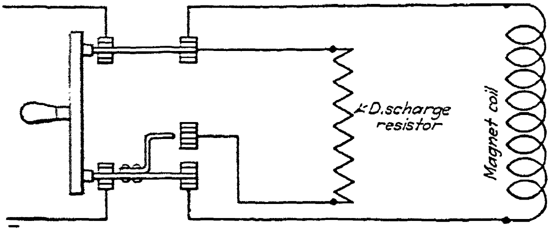


FIG. 148.—Field discharge switch replaces standard knife switch to protect magnetic circuit against induced voltage.

After a while, the magnet coils in two pulverizers failed. We then decided that the same fault which had caused the lamp failures was the cause of the coil breakdowns. The pilot light was wired to the load side of the switch, and we found that the lamp burnouts occurred each time the circuit had been broken because of the high-voltage surge produced. Also, the induced voltage was built up to a value that caused an insulation breakdown in the magnet coil.

A field-discharge switch was substituted for the standard knife switch. This switch was of the usual type having an auxiliary contact and blade, as in Fig. 148, that connected a resistance across the magnetic circuit when the supply voltage was disconnected, to absorb the high induced voltage. No further trouble has occurred.

Philadelphia, Pa. M. D. ROGERS.

482. Insulation Tests with a Megohmmeter.

Some engineers who have studied insulation-resistance measurement say that a meter of over 500 volts should not be used on 110- or 220-volt apparatus when the insulation is not in good condition. I am using a 500-volt meter to test insulation on rotating apparatus of 110 to 6,900 volts and use a 1,000-volt meter on a 25,000-kva. 13,800-volt generator with satisfactory results.

Great Falls, Mont. B. W. HAMILTON.

483-484. Faults and Weak Spots in Wiring.

483. A good method of locating faults in wiring or in cables is to use the device known as a "woodpecker" to supply an intermittent current through the defective conductor and the fault. The woodpecker is an interrupter that opens and closes the circuit about sixty times per minute. A device consisting of an exploring coil and a telephone receiver is used to listen in on the cable. The buzz of the woodpecker may be heard along the cable up to the fault. When the fault is passed, the sound due to current interruptions cannot be heard.

484. Weak spots in the insulation may be found by applying an overvoltage of about double operating value plus 1,000 between each conductor and the ground and between conductors. Lamps, motors, and other equipment should be disconnected from the circuits when the high-potential test is being applied. It is also advisable to connect an automatic overload circuit breaker in series with the source of high voltage so that in case of an insulation failure good wiring will not be destroyed by the arc that may develop. If insulation fails at some weak spot when the high-voltage test is applied, the exact location may be found by using the woodpecker.

New York, N. Y. GORDON R. HAHN.

485. Soldering Electrical Apparatus.

On many occasions, it is necessary to hold the soldering iron nearly horizontal. In such cases, only the upper side at the edge of the soldering iron should be tinned, since this results in a considerable saving in solder, time, and labor.

When both sides are tinned, the solder tends to run through the space between the soldering iron and the metal part. The amount of the solder thus dropped is usually much greater than that which flows into the joint.

Chicago, Ill. JAMES SILBERSTEIN.

486–489. Four Pointers on Soldering Electrical Apparatus.

486. The soldering iron shown in Fig. 149, with its wedge-shaped end, is a much more efficient tool for getting heat to the work and conveying solder than one with a pointed tip. When an iron with a pyramid end is used, the sides are on such an acute angle that it cannot satisfactorily convey sufficient heat to the areas to be soldered, whereas a wide or wedge-shaped soldering iron will not only fuse the solder speedily but also will heat and tin electrical apparatus satisfactorily. There are various sizes of wedge-shaped soldering irons employed on electrical apparatus, varying from ½ to 3 in. wide and from 1/16 to ¼ in. thick at the end.

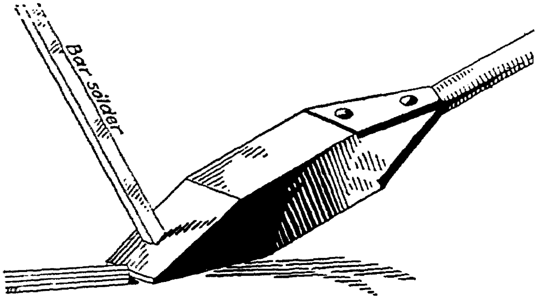


FIG. 149.—Wedge-shaped soldering iron.

487. When soldering certain electrical apparatus or upright seams on sheet-metal products or vertical pipe jobs in power plants, it is desirable that the soldering iron be wedge shape and tinned on the end and top side only.

488. When soldering many kinds of electrical apparatus, or for general benchwork, pointed irons can in some cases be advantageously used, with the four sides tinned for about ¾ in. from the point. Solder is generally applied to the tinned area on the iron and flows therefrom on to the areas or surfaces to be soldered.

489. Whatever type of soldering iron is selected, it must have capacity adequate for the work. This is a point often overlooked, even by mechanics. Much better results can be obtained by using a comparatively heavy soldering iron on light work than a light tool on heavy work. Only when the metal surfaces to be joined have absorbed the necessary heat to melt the solder freely can a properly soldered joint be secured.

Manchester, England. E. ANDREWS.

490. Insulation for Conductors in Damp Conduits.

In hydroelectric plants and in certain industrial plants, conduits may be run through concrete or buried in the floor where the temperature may remain fairly low in the conduit as compared to the air. In such installations a breathing action takes place, and condensation results. Maintenance, therefore, becomes burdensome owing to burnouts and grounds if the standard code rubber or varnished-cambric insulation is used.

I have found that for voltages below 500 volts, good results may be obtained with the use of 30 per cent Para rubber insulation with a single braid for protection during installation. Where the cost is justified by service requirements, or where the conductors may be immersed at times, a special compound insulation may be preferably used. The latter may be used in place of varnished cambric insulation in damp locations for voltages up to 13,800 volts where the use of lead-covered cable is not suitable.

Alcoa, Tenn. J. ELMER HOUSLEY.

491. Unloads Air Compressor to Keep Down Peak Loads.

In a mine where an electrically driven compressor and hoist are operated, the devices shown in Fig. 150 were installed to keep maximum power demand down to a given value. On the maximum-demand meter, two contact points *P* were adjusted to close at a certain position of the pen arm. Closing contacts *P* caused the contactor above the compressor pilot valve to be energized. The contactor arm is connected by a small spiral spring to the pilot-valve level; thus, when the contactor closes, the pilot valve is lifted to unload the compressor.

The contactor also actuates an electric switch that operates a red light in front of the hoisting engineer. The pen arm on the maximum-demand meter keeps rising during each 15-min. period, the rate at which it rises depending upon the load.

At the end of each period the arm drops, opening the small contact points on the meter. At the same time, the contactor on the compressor drops, releasing the pilot-valve lever. The idling compressor then goes into service again. The red light goes out, and hoisting can begin.

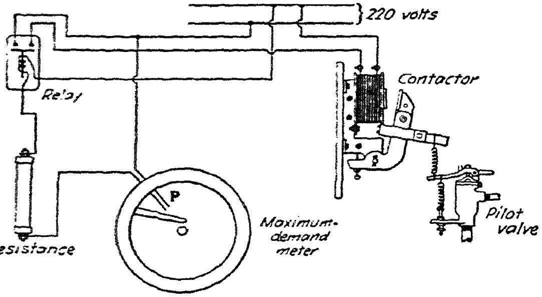


FIG. 150.—Devices to keep maximum demand below limit of contract.

It has been found by trial that nine skips can be hoisted in a period without exceeding the peak limit.

Ironton, Minn. O. W. LEKSTROM.

492. Daily Record of Power Factor.

Plants that purchase power under a contract imposing penalties for low power factor are frequently equipped to improve power factor by proper use of static condensers or overexciting synchronous machines. The average power factor during the billing period is determined from readings of the kilowatt-hour meter and the reactive kilovolt-ampere-hour meter. Daily meter readings will give a picture of the average power factor.

The operator of the power-factor improving equipment can, without computations, make his daily entries on a chart, as in Fig. 151, that will show the effectiveness of operation. On a sheet of cross-section paper, a scale is drawn along one side representing the range of the kilowatt-hour during the entire billing period, and at right angles to this another scale is laid off for the reactive kilovolt-ampere-hour meter readings. Each day's reading is then entered as a single point in the space inclosed by both scales, and the successive points connected by straight lines. Through the point of beginning, straight lines are drawn denoting different power factors. The angles of these lines

Degrees	Power factor, per cent	Degrees	Power factor, per cent
11.5	98	25.8	90
16.3	96	28.4	88
20.0	94	30.7	86
23.1	92	32.9	84

against the kilowatt-hour scale are as given in the table, or they may be taken from a table of cosines.

The inclination of the line connecting two successive points gives a measure of the power factor during the particular day by comparing it with the line to which it is most nearly parallel. The line connecting the point of beginning with any other point representing a later reading gives the average power factor represented by the period between the two points.

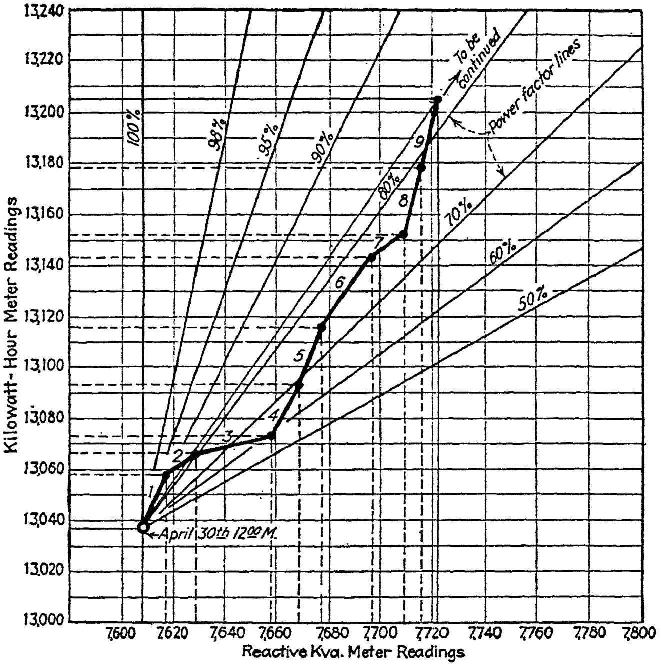


FIG. 151.—Zigzag line shows average daily power factor from May 1 to 9.

East Pittsburgh, Pa. KURT MAHNKE,
Power Plant Operator,
Westinghouse Electric & Manufacturing Co.

493-496. Four Pointers in Testing Cleanliness of Knife Switches.

493. The cleanliness of the blades and contacts of a switch or the contacts of a circuit breaker can be checked by a drop test. Perfect contact between the movable and fixed contacts is often prevented by a thin film of oxide and dirt. Apparatus needed is a millivoltmeter, two lengths of flexible wire terminating in contact points, and two insulated handles.

494. The test is made when current is flowing, the two contacts being held on the two switch terminals. The deflection on the millivoltmeter will show the voltage drop across the switch. In the case of a perfectly clean switch, voltage drop should not exceed 10 millivolts and can be even lower.

495. The best way to remove this film, in the case of an ordinary knife switch, is to cut off the current, give the blades a thin coat of vaseline, and work the blade in and out several times. Then wipe both the blades and the contacts clean and work the switch as before.

496. In the case of circuit breakers, both the fixed and the movable contacts should be kept clean and bedding together perfectly. The best way to clean copper contacts is with a paste made of fine pumice powder and machine oil. It is not good practice to use emery paper for this work, as the hard emery grit is liable to get embedded in the soft copper surfaces; also, emery is a conductor of electricity. Finally, clean away every trace of the cleaning paste.

Brentford, England. W. E. Warner.

497-500. Four Pointers on Circuit-breaker Maintenance.

497. Many operators are not acquainted with details of air circuit-breaker maintenance. Cleaning should be stressed. Aside from blowing the dirt out of the mechanism with compressed air, cleaning of the contact surfaces is of even greater importance. An accumulation of oil vapor and dust on contact surfaces increases the temperature rise of the breaker, assuming that the major features of maintenance, such as alignment of parts and proper contact pressure and area, have been properly looked after.

498. Sandpaper should be avoided on main contact surfaces, as it grooves the area and increases the amount of dirt retained;

likewise a considerable amount of metal is removed, and in time the flat surface is destroyed. Metal polish is better to clean contact surfaces. It should also be used to clean telephone-switchboard plugs, potential and current plugs, and knife switch blades or in any place where a loss of metal will destroy the fit of current-carrying parts that must be kept clean to prevent high resistance.

499. In some older designs of auxiliary switches used with air-break circuit breakers for operation of interlocks and signal lights, the contact springs do not have sufficient strength and become inoperative. Generally, this trouble can be eliminated by making new spring contacts from phosphor-bronze spring stock of slightly thicker section than the old contacts.

500. All nuts and screws should be examined and tightened every month. At times, loose contacts cause faulty operation of the control of remotely operated breakers and may cause considerable damage to equipment. When tightening terminals on control wiring it is essential to try the wire under the screw or nut when cup washers are employed. These washers may become sprung, and the pressure is insufficient to grip the wire. Unless the wires are held securely, loose contacts in the control wiring will be found after three or four operations of the motor-driven closing devices on oil circuit breakers. Regular inspections are essential, and proper lubrication is paramount on all motor-operated devices if operating failures and interruptions to service are to be avoided.

Alcoa, Tenn. J. ELMER HOUSLEY.

CHAPTER VII

OIL AND GAS ENGINES

501. A Difficult Foundation Job.

Some time ago, we sold a 200-hp., 460-r.p.m. vertical diesel engine and generator to operate in parallel with an existing water-power plant. The engine was sold with the understanding that we put in the foundation and assume all responsibility.

On going to the site to lay out the foundation, we found it to be 200 ft. down an embankment on the side of a small river, close to the dam. We sank a test hole, or tried to, for after digging 6 ft. down the hole filled with water; rods were obtained and forced down 25 ft. by hand with ease. We endeavored to have the site of the engine changed and operated by remote control, but the purchasers refused.

Eventually we decided to construct a mattress, as piling was prohibitive. We excavated and pumped the material (a water-logged sandy loam) from a hole 60 by 40 by 10 ft. deep, preventing the hillside from coming into the hole by sinking large stones and brushwood as we went down. It was a difficult job, and we were discouraged several times when a stone weighing ½ ton went out of sight almost as soon as it was rolled in. Eventually severe frost came, which helped matters, and we were able to get a brush and stone layer over the whole area, about 6 ft. thick, with a concrete top of 4 ft. Before placing the concrete we laid 6 in. tile around the outer edge and through the center to take off spring water and seepage from the hill. A standard foundation was then built for the engine.

When the installation was finally completed, the engine operated satisfactorily, and vibration was negligible.

This plant has been running eighteen months now and looks as though it were on rock. We have room for a second unit on the mattress, for which we are expecting the order at any time. With few exceptions I believe a mat is better and cheaper than piling, especially in an isolated position where a pile driver is difficult to obtain.

Toronto, Ont. G. H. Hoyles.

502. Stabilizing an Engine Foundation.

A slow-speed gas engine of fairly large size had been mounted on a concrete foundation built upon unstable ground. The engine had not been long in service when the foundation began to rock. Since no means could be devised for giving the foundation block a firmer anchorage in the soft ground, it was decided that the only solution was to increase its static inertia. It was figured that if the foundation's center of gravity were shifted to a point nearly beneath the axis of the crankshaft, the rocking tendency would be diminished or abated altogether.

The procedure was first to drill and chip two rectangular holes in the front end of the foundation block, each to a depth of about 20 in. and at a distance from the vertical edge of the block equal to an eighth of its width. Heavy steel I beams 5 ft. long were inserted in these holes, and a grouting of rich gravel concrete was blown in around them.

Two masses of concrete to hang on the projecting ends of the steel beams were then poured in wooden forms, a rectangular duct of wood being fastened in each form in the proper position for coring out the necessary holes.

By means of a tackle suspended from a tripod over the engine, these blocks of concrete were slipped along the protruding girders to contact with the main foundation structure. Cement grouting was then blown in to fill the identations in the abutting surfaces, which previously had been well nicked.

The additional weight of approximately 5 tons removed all tendency of the foundation to rock. The improvement was worked out at considerably lower cost than any attempt at strutting or solidifying the ground under the structure would have entailed, had such a plan been feasible.

St. Louis, Mo. A. J. Dixon.

503. Improving Contact of Engine Bed.

An engine operating on producer gas had its crankshaft running in three bearings, two integral with the main frame on either side of a center crank, the third set upon a separate foundation.

The arrangement proved troublesome; the main foundation persisted in settling faster than the foundation of the outboard bearing, and chronic heating of the three bearings was the result. The evil was much intensified by reason of the scant area of contact which the main frame made with its foundation.

The difficulty was rectified by jacking up the machine and slipping two plates of ½-in. steel beneath its bed longitudinally with the main foundation. Slots cut in each plate accommodated the foundation bolts. The plates were long enough to bridge the gap between the main and auxiliary foundations and pass beneath the pedestal of the outboard bearing. The effect was to give the base an area of footing approximately four times greater than it had in the first place. Thus the concentration of stress per unit of area was much reduced, and the stability of the foundation improved.

St. Louis, Mo. A. J. DIXON.

504. Keep the Engine Foundation Free of Oil.

The deteriorating effect of oil on concrete foundations is probably little appreciated by the average diesel engineer.

I recommend keeping foundations well painted. I also recommend use of a high-grade filler before the paint is applied. Oil should be kept wiped up, or sawdust used to absorb the oil and help keep it from going into the concrete.

Kimball, S. D. ART WILLIAMSON.

505. Temperature Corrections for Baumé Gravity Readings of Fuel Oil.

Fuel oil is usually purchased on a volumetric basis, from drums to tank cars, generally in terms of gallons. The usual guide for the quality of the oil, upon which price depends, is the Baumé gravity. The higher the gravity reading the greater the value of the oil. A high-gravity oil is usually lighter in density, less viscous, cleaner, and more easily burned.

The gravity is usually determined by placing a glass hydrometer, graduated in Baumé divisions, into the oil, wherein it sinks to its equilibrium point, at which the reading is taken.

The higher the temperature of the oil the less dense it becomes, and a higher reading of the hydrometer is obtained. Hence, within limits the Baumé reading becomes a function of the temperature of the oil.

For this reason it is well worth while to watch carefully at what temperature hydrometer readings are taken and that a standard temperature be used to which other temperatures should be corrected.

The following table is suggested for correction of American petroleum oils for Baumé readings at various temperatures:

Observed temperature, degrees Fahrenheit		Observed Baumé gravity readings						
		20	30	40	50	60	70	80
50	Add	0.6	0.7	0.8	1.0	1.2	1.4	1.6
52		0.5	0.6	0.7	0.8	1.0	1.1	1.3
54		0.3	0.4	0.5	0.6	0.8	0.9	1.0
56		0.2	0.3	0.3	0.4	0.5	0.6	0.6
58		0.1	0.1	0.1	0.2	0.3	0.3	0.3
60		0	0	0	0	0	0	0
62	Subtract	0.1	0.1	0.1	0.2	0.2	0.3	0.3
64		0.2	0.3	0.3	0.4	0.4	0.6	0.6
66		0.3	0.4	0.5	0.6	0.7	0.8	0.9
68		0.4	0.6	0.6	0.7	0.9	1.1	1.3
70		0.5	0.7	0.8	0.9	1.1	1.4	1.6
72		0.6	0.8	0.9	1.1	1.3	1.6	1.9
74		0.7	0.9	1.1	1.3	1.6	1.8	2.2
76		0.8	1.1	1.3	1.5	1.8	2.1	2.5
78		0.9	1.2	1.4	1.7	2.0	2.4	2.8
80		1.0	1.3	1.5	1.8	2.2	2.6	3.1
82		1.1	1.4	1.7	2.0	2.5	2.9	3.4
84		1.2	1.5	1.8	2.2	2.7	3.2	3.7
86		1.3	1.7	2.0	2.4	2.9	3.4	4.0
88		1.4	1.8	2.1	2.6	3.1	3.7	4.2
90		1.6	2.0	2.3	2.7	3.3	3.9	4.5

An example of the use of the correction table would be as follows:

An oil is purchased and tested with a hydrometer at a temperature of 84°F. and found to read 30°Bé. Since the oil is purchased on a base temperature of 60°F., the true reading at 60° temperature would be lower than at 84°. According to the table, at 84° for 30°Bé. oil, 1.5 should be subtracted, so that the oil should actually read 28.5°Bé. at 60°F.

Dayton, Ohio. F. M. AHER.

506. Pointers in Correcting Fuel-oil Volume.

The U.S. Bureau of Chemistry gives a factor of 0.00064 per degree centigrade as the average of most vegetable and mineral oils. With the Fahrenheit scale, used by the petroleum trade, this factor becomes 0.000355. The correction book for the Baumé scale was figured for paraffin-base oils, while most fuel oils are either from mixed- or naphthene-base oils which do not conform exactly to the standard scale.

For rough calculations it is customary to add or subtract 1°Bé. for each 10° fall or rise in temperature from the standard (60°F.). With commercial gasolines this gives close results, since the factor is about 0.0004 per degree Fahrenheit. With heavy oils or with very light gasolines, this is not accurate. Then a correction table is used, or the oil is tested by hydrometer after heating or cooling to 60°F.

Residual materials from the various cracking processes are extensively used for fuel. On running tests with residuals from the Mid-Continent field, I have found that the heaviest of these contain tarry substances, which, when removed, raise the Baumé gravity of the clarified oil 3 to 4° and reduce its viscosity very materially. Thus a 10 to 12°Bé. oil becomes 14 to 16°Bé., which is to be preferred.

The paraffin-base oils are confined to the Appalachian and Wyoming fields, though some Oklahoma oils are similar. The naphthene- (asphalt-) base oils have a more complex composition, approximating that of the benzol ring, $C_6H_6 + x(CH_2)$. The residue from cracking is similar to tar or asphalt. Various other combinations have been identified, but the two mentioned are in the majority.

The Mexican field has furnished some freak oils. One was heavier than water and yielded 25 per cent of straight-run gasoline. Another, with a viscosity of 2,700 sec. (practically that of a grease), yielded straight-run gasoline and kerosene and left a fuel oil with a viscosity of 300 sec., reversing the usual procedure.

Cleveland, Ohio. L. R. BAKER.

507. Improved Centrifugal Engine Oiler.

An improved crankpin oiler is shown in Fig. 152. The bearing shell is flanged, and the oil ring shaped to encircle the flange with about $\frac{1}{32}$ in. clearance. In this way, a closed trough is formed, in which lubricating oil is fed through a $\frac{1}{8}$-in. pipe, the end of it being located in a hole filed in the flanges of the top and bottom bearing shells, some clearance, of course, being allowed.

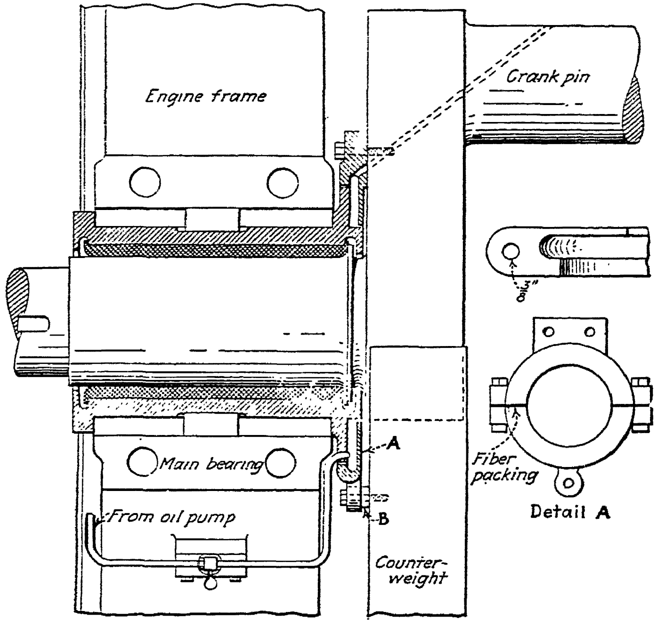


Fig. 152.—Oiler attached to crank and counterweight.

The top part of the oiler is connected to the crank web by two $\frac{1}{2}$-in. cap screws, and the bottom part by one $\frac{3}{8}$-in. The bottom screw is slipped through a $\frac{1}{2}$-in. bushing *B*. This bushing is screwed down until it touches the counterweight, and the ring is finally fastened by means of the $\frac{3}{8}$-in. cap screw, thereby making a good connection without straining the oiler. As counterweights are usually rough castings, this method is simple and practical.

The top and bottom parts of the ring are connected by two $\frac{3}{8}$-in. bolts with a $\frac{3}{16}$-in. fiber packing on the joint to provide some flexibility when the oiler and flange are not exactly in line.

Epe, Holland. H. Wieland Los.

508. Cleaning Diesel Oil-pump Nozzle.

Our diesel engines are equipped with valve devices that shut off the fuel supply whenever the pressure fails on the lubricating-oil line. Pressure is created by an overhead tank into which the oil pump, driven by the engine crankshaft, discharges oil pumped. In spite of filters and changing the oil often, the relief nozzle that prevents the pump from becoming airbound became stopped up.

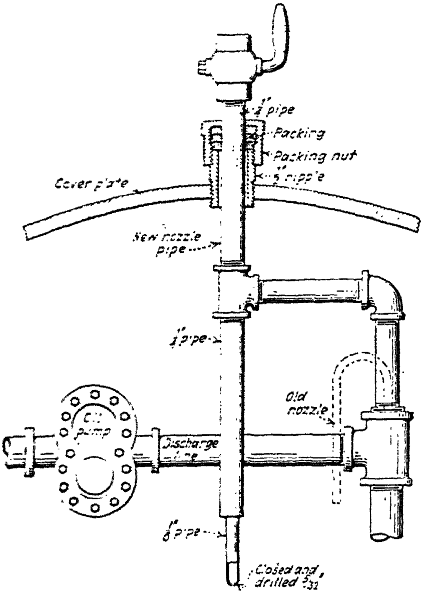


FIG. 153.—Device to enable oil-pump air nozzle to be cleared.

After several of these stoppages I devised the plan shown in Fig. 153. By this arrangement of piping, the nozzle can be cleaned at any time with a piece of No. 9 telephone wire, using a wad of waste held tightly in the hand on top of the stopcock while the wire is being run through the pipe and nozzle. The cover plate was drilled and tapped for ½-in. pipe, in the proper place, and an old valve packing nut drilled to fit the ¼-in. pipe snugly.

If no packing nut is available, a ½-in. pipe cap will do as well. In fact, though our piping was arranged for packing, we have never used any yet. Another advantage of this piping scheme, besides cutting down the labor of taking off the cover plates, is that a smaller hole can be used at the nozzle, since it can be cleaned so easily and often.

Abras Grandes, Cuba. THOMAS C. HULTON.

509. Oil-level Alarm for Fuel-oil Tanks.

After several shutdowns through operators' letting fuel tanks run dry, we equipped each engine with a simple alarm that has proved entirely satisfactory. Figure 154 is self-explanatory.

Pomfano, Fla. H. C. CUNNINGHAM.

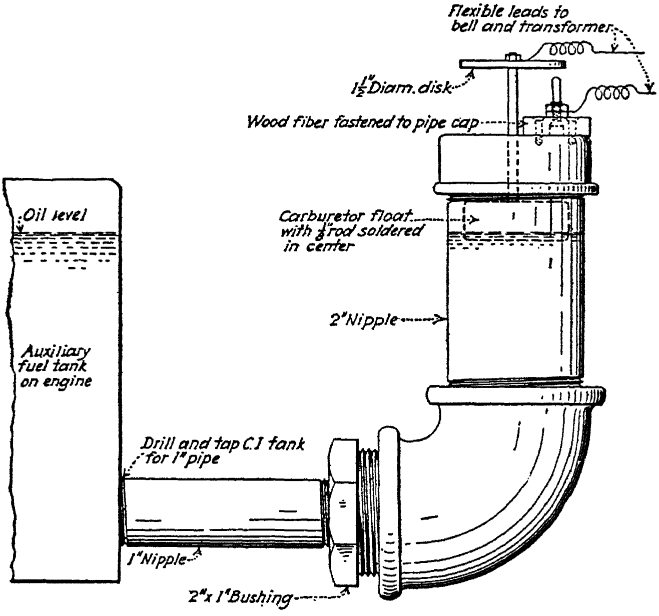

Flexible leads to bell and transformer
1½" Diam. disk
Wood fiber fastened to pipe cap
Oil level
Carburetor float with ⅛" rod soldered in center
2" Nipple
Auxiliary fuel tank on engine
Drill and tap C.I tank for 1" pipe
1" Nipple
2"x 1" Bushing

FIG. 154.—Alarm warns of lowered fuel-tank oil level.

510. Danger in Using Volatile Oils on Diesel Admission Valves.

Here is a necessary precaution in the use of kerosene mixture for lubricating the valve stems of four-cycle diesels. Some engine manufacturers prescribe two-thirds kerosene and one-third oil as a lubricant for the admission and exhaust valves. The kerosene is to prevent carbon from forming on the valve stem and seat.

I have found that care must be taken not to use this mixture too freely, especially on the admission valves. An oversupply will be drawn into the cylinder and vaporize into a combustible mixture that will preignite and cause a detonation. This precaution is not necessary with the exhaust valve, because there is no tendency for the mixture to be drawn in, and it is discharged with the exhaust gases.

Kimball, S. D. ART WILLIAMSON.

511. Old Valve Serves as Strainer When Fitted with Screen.

A practical strainer for fuel-oil supply is shown in Fig. 155. An old valve, from which the stem and disk had been removed, was inserted in the pipe line. A cylinder, with one end of fine-mesh copper filter screen, was then made to fit tightly in the valve body, the bonnet holding it in place. The stem opening in the bonnet was closed with a metal disk and two pieces of leather. If desired, disks of felt can be inserted in the screen cylinder and thus make the strainer more effective in removing finer particles.

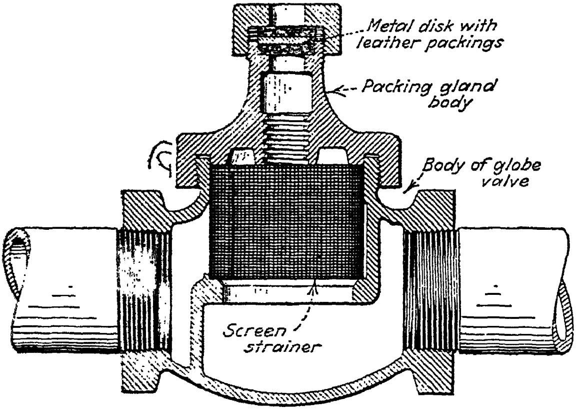


FIG. 155.—Screen fitted in valve body for fuel-oil strainer.

Washington, D. C. G. A. LUERS.

512-513. Two Advantages of Preheating.

Until recently, we were burning a mixture that resulted in an oil of about 21 to 22°Bé. However, certain events made it desirable to seek further economies in fuel.

512. The oil heating system was extended and made more direct, to secure free flow of heating water used to heat oil. Piping was covered with lagging of material on hand. The total expense of making these changes was under $10. A considerable increase was noticed in the temperature of the fuel oil at the engine pumps. Since then we have used mixtures of 19.3°Bé. and also of 18.6°, which last has been adopted as standard.

513. We use a gravity oil-washing system consisting of a water-jacketed tank in which the old lubricating oil is mixed with sodium carbonate and kept at as high a temperature as we can raise until the sludge is precipitated, after which the clean oil is drawn off. By making the changes we obtained a higher temperature in the water discharged from the fuel-oil heating system, which was used, in turn, to maintain the heat of the mixture in the lubricating-oil filter, incidentally improving the separation of the clean oil from the sludge, with a consequent increase of clean oil recovered from each batch.

Abras Grandes, Cuba. THOMAS C. HULTON.

514. Oil-storage Thermos Flask.

An oil-storage thermos flash or insulated vessel designed to hold a certain quantity of oil at a temperature suitable for quick starting over short shutdown periods is shown in Fig. 156. To use this thermos flask the drain cock is first opened; then steam

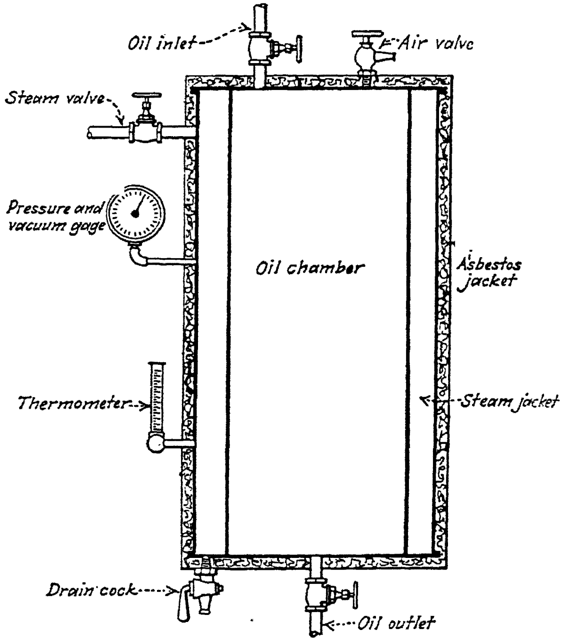


FIG. 156.—Insulated steam-heated oil-storage tank.

is admitted until the vessel is thoroughly warmed up. The air valve is opened, and the vessel filled with hot oil; then both oil and air valves are closed. Steam is turned on until dry steam comes out of the drain cock, when both steam valve and drain cock are closed.

The steam jacket will have to resist atmospheric pressure when the steam condenses, creating a vacuum which will register on the gage. With all valves closed tight the oil is held at the required temperature for a considerable length of time.

Montevideo, Uruguay. E. Kerr.

515-519. Five Pointers on Filtering Diesel Lubricating Oil.

515. Our practice at first consisted in pumping oil from the crankcase directly through our centrifuge. We obtained a fair amount of carbon in the bowl, but the appearance of the cleaned oil indicated that a considerable amount of carbon remained in the oil, some of which a second run removed.

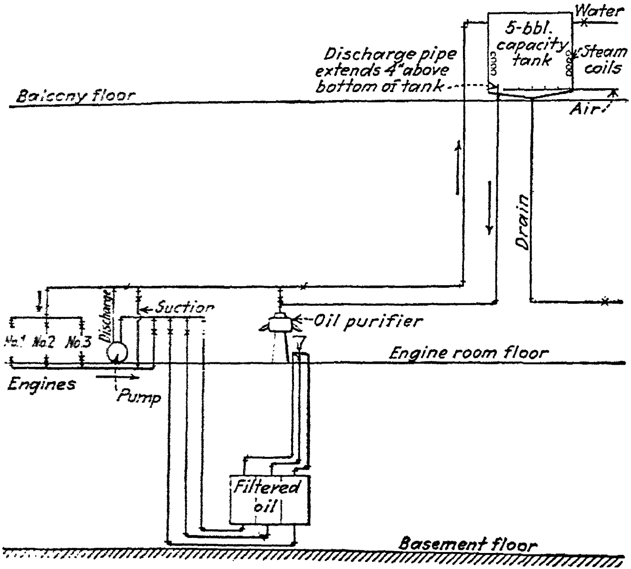


Fig. 157.—Tanks and piping for washing and purifying lubricating oil.

We started, on a small scale, to wash the oil. We first tried water and soda and water alone, which seemed to give satisfactory results; so a 5-bl. steel tank was installed in connection with the purifier.

Figure 157 shows how the purifying installation would be made if it were to be done over again. We have learned by experience that several mistakes were made in the original installation. One was placing the steam lines in the bottom of the tank, which made it difficult to clean the tank bottom. Also, we arranged for the oil to settle in a tank in the basement and then pumped it up to the heating tank. This, of course, made the layout more complicated and added to the work of handling the oil.

516. The proposed procedure is first to pump the oil from an engine to the combination heating and washing tank, which should contain several inches of water. The air and steam should then be turned on and continued until the temperature reaches approximately 180° and then turned off, and the water and sludge allowed to settle to the bottom of the tank. Oil, sludge, and water should be allowed to remain for a week or more if possible. The drain valve should then be opened until the oil starts to come through. The oil is again heated to about 180° and run through the purifier and into one of the reserve tanks in the basement. It can then be pumped back into an engine whenever desired.

517. Reference to the sketch will show that the oil in any engine can be pumped continuously through the centrifuge and back into the engine while it is in operation.

518. Some engineers might favor saving the oil that remains in the tank as a result of the discharge pipe's extending about 4 in. above the bottom. In that case, the remaining oil could be drained into a barrel and combined with the remaining oil from previous filterings. After standing for some time, much of the oil in the barrel could be siphoned off and used again.

519. The present plant routine calls for a continuous treatment of the oil in the 750-hp. unit (run 12 hr. daily) for 6 hr. a day and a batch treatment once a month. The other two units are run less, so their oil is given only a batch treatment once a month. This practice seems to keep the crankcase oil in good condition and the crankcase clean.

Sioux City, Iowa. J. WILLARD PETERSON.

520-523. Four Pointers on Filtering Lubricating Oil.

520. In the 5 bl. tank place 200 gal. of oil, adding to it 3 lb. of soda ash which has been dissolved in a gallon or two of water.

Then pipe live steam directly into the bottom of the tank, to raise the temperature to 180 to 200°, before discharging the oil through the centrifuge.

521. With very dirty oil, connect a ¼-in. hot-water line into the feed pipe of the centrifuge. With a properly designed machine, the carbon will be flushed out as a thick paste which is almost solid when cold, and the machine can be kept running indefinitely.

522. Should no steam be available, oil may be heated by the exhaust from the engines, the soda solution with a little extra water added, and the mixture stirred by hand, or mechanically, compressed air being effective, though live steam seems to coagulate the carbon to a slight degree.

523. Silicate of soda and trisodium phosphate may be used but are more expensive and usually not so available. Sal soda may be used in place of soda ash, but it will require two and one-half times as much.

This gives a clean oil and, with the proper adjustment of the centrifuge, less than 0.02 per cent of water, which is not enough to do any harm.

Cleveland, Ohio. L. R. Baker.

524. Valve and File Made into Valve-seat Facer.

When cylinder heads were pulled during the annual overhaul of a 200-hp. gas engine, valves and seats were found pitted and scored beyond regrinding. New seats were not available, and the unit was needed. It appeared necessary to send the heads to a machine shop to have the valve seats refaced. This would have cost $12 per head and considerable delay.

The assistant chief engineer selected a discarded valve with a true stem and made hack-saw cuts across its beveled face to a depth slightly more than the thickness of an 8-in. mill file. The metal was then removed between the cuts to make a shallow slot, or notch, into which the file would fit snugly. With the file inserted, the valve was rotated on the seat with a bitbrace and the standard grinding yoke. This quickly removed pits and ridges, leaving only minimum or touch-up grinding to put the seats into condition.

The slot was deepened slightly on the leading edge of the file, so all cutting was done by the trailing side of the file teeth, thus preventing chattering.

The improvised seat facer did not, of course, perfect a valve seat which was out of true or warped. After the high side of the seat was determined with feelers and a new valve, it was possible to rotate the file through an arc to file away the high section. Thus the seat could gradually be brought back to condition where final grinding would again put it round and in line with the valve guide.

One workman working steadily with the improvised reamer was able to rough down the seats as fast as his mate could finish-grind them. The four heads were pulled, valves ground, and ports refaced in the time that other members of the station crew were renewing piston rings and tightening rod and main bearings.

Longview, Tex. ELTON STERRETT.

525. Repair of Cylinder Liner.

A cylinder liner had a crack about 5 in. long extending straight down the liner from a point just under the upper flange. We decided to make an attempt to repair it with iron cement.

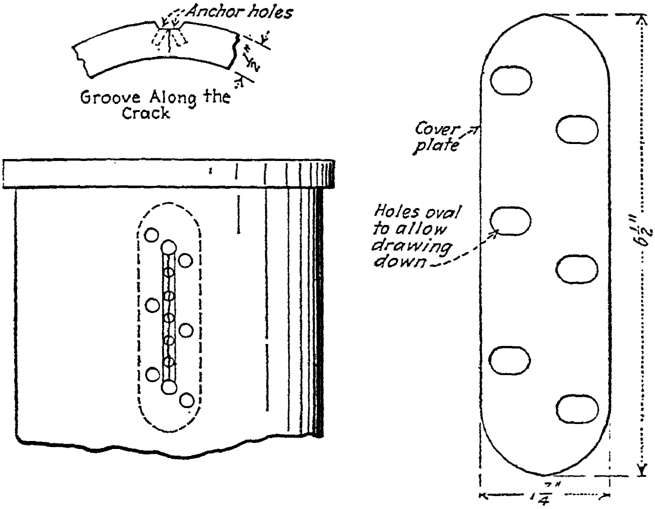


FIG. 158.—Method of repairing liner.

A ⅜-in. hole was drilled at each end of the crack as deep as possible without penetrating through the liner (Fig. 158). With a round-nose chisel a channel about 5/16 in. wide and of equal depth was cut to join the ⅜-in. holes. At intervals along this channel, $\frac{5}{16}$-in. holes were drilled at an angle to provide anchorage for the cement. A cover plate $6\frac{1}{2}$ in. long and about $1\frac{3}{4}$ in. wide was dished along its length, shaped carefully to the liner, and drilled for $\frac{5}{16}$-in. cap screws. The holes were filed oval to allow for drawing down the cover plate without crowding the cap screws. Holes were then drilled and tapped in the liner to correspond with the holes in the cover plate, which was tested for fit and alignment.

The cover plate and channel in the liner were filled with Smooth-on No. 1 well tamped in. The cover plate was then put in place, and the cap screws tightened with a small, light wrench, until all were snugly seated. Care had to be exercised to get full threads in the tapped holes and to have the cap screws fill the holes snugly when the plate was drawn down to place.

Abras Grandes, Cuba. THOMAS C. HULTON.

526-527. Two Repairs on Pistons by Welding.

Five pistons for 29-in. stroke, horizontal twin-tandem, double-acting gas engines were recently repaired by arc welding. Ring grooves had been re-turned previously, and wider rings used to compensate for wear. The periphery of the pistons had also worn down to such an extent that blow-by could not be prevented, causing stuck rings and piston rings and grooves badly burned.

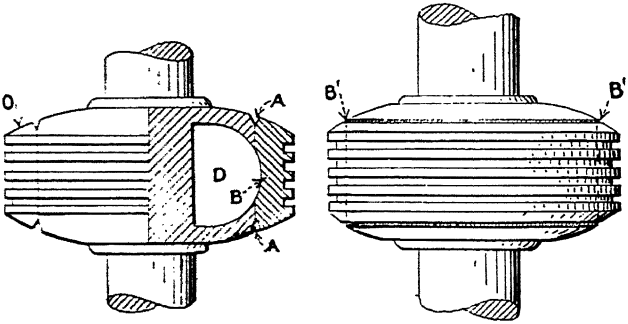


FIG. 159.—Method of renewing piston-ring grooves.

526. Pistons were turned down to water cavity *D* (Fig. 159), and steel casting *B* made to take the place of the metal removed. This ring has the same width and diameter as the original piston face and is about 5 in. thick.

In addition to a careful shrink fit, the casting and original body of the piston were arc-welded together, V grooves being cut at the junctions *AA*.

Vertical welding was employed to assure thorough penetration and a careful weld. The cost was less than 10 per cent of new pistons, and the work required only a few days after the steel casting rings were obtained.

527. The piston rods had worn oval, the wear taking place on the lower side, as is usual, which also allowed the piston to drag on the liner and permitted blow-by at the top. The first repair to the rods had been carried out by turning down the rod to a smaller diameter and building up the stuffing box to fit. Since this could not go on indefinitely, another method had to be worked out. This consisted of building up the worn shaft by depositing new metal with the arc. The shaft, of course, had to be turned down in a lathe after welding was completed.

Dallas, Tex. ORVILLE ADAMS.

528-532. Five Pointers on Welding Gas-engine Pistons.

In my opinion, the above job could have been done more economically using manganese bronze applied with a torch.

528. Enough bronze is placed on the ring to allow machining down to the required size. The piston is then placed in a lathe, turned to size, the packing-ring grooves cleaned out, and the edges of the grooves chamfered. Chamfering is important, because otherwise the bronze will work over the edge of the packing-ring grooves and bind the rings, causing a blow. Just

Element	Per cent		
Copper	57.60	59.21	58.31
Zinc	40.14	38.44	39.57
Tin	0.79	0.76	0.58
Lead	None	None	None
Iron	1.45	1.48	0.88
Manganese	0.0	0.11	0.04
Phosphorus	None	None	None
Aluminum	None	None	0.59
Undetermined	0.01	None	0.03
Total	100.0	100.00	100.00

enough of the corner should be beveled off to make certain that the packing will be free. Between 3/16 and 1/4 in. is ample.

529. Another detail that must be watched is the kind of bronze used. Tobin bronze is too ductile and soft. Manganese bronze should be used. On page 289 is the chemical analyses of three bronzes which have been found satisfactory.

530. It must be understood that the manganese used in making bronze is a scavenger, which removes oxides and other impurities to the slag. The residual manganese is unimportant, 0.01 per cent being as satisfactory as 0.10 per cent.

531. As to the relative economies of welding a new annular ring on a piston and building the pistons up with bronze, it is necessary only to enumerate the steps required by each method. Welding on annular rings would require the following steps: Turn down piston in lathe, chamfer edges of piston, purchase steel casting for outer ring, machine inside of casting to shrink fit over piston, shrink casting on piston, electric-weld casting to piston, and finish piston in lathe. In comparison, building up a piston with bronze requires only three operations: Clean outside of piston for welding; build up piston with bronze (do not build up over packing-ring grooves); and finish in lathe. The packing-ring grooves merely require cleaning out at the outer edge.

532. Bronze is a better bearing metal than steel, and a piston is, in so far as its movement is concerned, a bearing sliding on the cylinder walls, so a piston may not only be built up with bronze more cheaply, but it will perform the work with less friction, less wear on the cylinder walls, and at least an equal life of the piston proper.

Springfield, Mo. S. H. Acker,
Engineer of Tests, St. Louis & Santa Fe Railway.

533. Simplified Piston Installation.

A ring pot, or metal band, is cast or rolled from heavy plate steel and given a bevel of about 3 in. per foot on the inside. It should be 7 or 8 in. high for engines with pistons up to 14 in. in diameter. If a casting is used, the pot should be made to fit between the cylinder-head studs and the counterbore and may be provided with a flange at the bottom and drilled to center fast against the bolts for rigid support.

When the rings are properly oiled, as they usually are for entering, they slip into the cylinder readily. Rings which must be registered with dowels or multiple-piece rings require only to be properly placed in order to work in the same manner as plain snap rings.

Dallas, Tex. ORVILLE ADAMS.

534-535. Two Pointers on Replacing Pistons in Diesel Engines.

534. We use a ring guide for compressing rings. The small end of the ring guide should be the same size as the top of the cylinder bore, with a widening of the bore of the guide to the size of the piston ring when released from the cylinder.

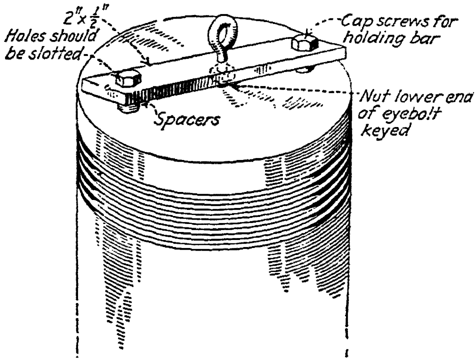


FIG. 160.—Bar used for slinging pistons.

535. For handling pistons we made a lifting bar, which we find better than eyebolts and a sling. The bar is of strap 2 by ½ in. and of a length that it will fit inside the cylinder, allowing ¼ in. at each end to clear the cylinder walls. Figure 160 shows the bar attached to a piston.

Cedar Rapids, Iowa. W. L. DINGWALL.

536. No More Plugged-piston Water Lines.

Our diesel dredge operated in shallow water, and at times the cooling-water system became plugged. As the pistons are water cooled, it was especially difficult to keep them from overheating. Because of the small diameter of the telescopic tubes, they would plug up very easily, and the engines at times had to be shut down in order to clear the pipes.

As piston-water discharge temperature usually is carried about 20° higher than the discharge water from the cylinder jackets, we figured that by letting water go first through the cylinder jackets and then through the pistons, most of the sediment would settle in the jackets, where it could be drained off at regular intervals. We also put a duplex strainer between the cylinder discharge and the pistons.

The change was made at little cost and has proved entirely satisfactory, regarding both the temperatures of the piston discharge water and elimination of the mud trouble.

New York, N. Y. CHARLES T. ANDERSON,
Dredge "W. L. Marshall."

537. Oil-engine Piston Growth.

One engine was fitted with rebored cylinders, and the other was waiting the arrival of a set of rebored cylinders. During the wait the engine with the worn cylinders developed a heavy pound, which seemed to be in the crank box. This box and the piston-pin bearing were both set up as closely as they would run without heating. The pound came and went with the increase and decrease in load and occurred at the end of the exhaust stroke or at the beginning of the suction stroke.

Since the bearings were known to be in good shape, we decided to pull the piston as soon as we could shut down. When the cylinder head was lifted, the first thing that we saw was a badly charred piston top. The eyebolt holes were almost unusable, even after retapping, and a bright worn band ran around the piston just below the head.

This was an old piston and was to have been scrapped when the new set came in. Its burned condition was the cause of overheating, and the mass had not been able to contract to its original diameter. On the contrary, every day's run was adding to its diameter.

The piston was placed in a lathe, and a $\frac{1}{32}$-in. cut taken down to the first groove. The center rest was then offset, and a taper cut taken over all the group of ring grooves. During the remainder of its life this piston did not give any trouble.

It seems unreasonable that the piston should be able to touch the cylinder head. But close inspection will locate points of contact occasionally on the curve of the deflectors. A cold chisel and hammer will relieve the noise; an extra-thick gasket under the cylinder head will also relieve it. This contact is not caused by lengthening of entire piston but by the expansion of the piston in the concave and a converse expansion of the cylinder head on the convex surfaces.

Covington, La. F. C. WILLIAMS.

538. Broken Piston Rod Causes Knock.

In overhauling one of our two-cycle crosshead-type diesels, piston 2 came out of the cylinder minus the piston rod. This quickly identified a knock we had experienced during the last three revolutions of the shaft when the engine was being shut down. The engine ran as quietly when under load as it did when installed.

In our efforts to find the cause of this knock, we had checked all bearings and crossheads. We had also pulled pistons, thinking that a piston might be sticking at low speed.

That this rod had been broken for some time was indicated by the condition of the parted ends of the rod. The rod is tapered and fits into a plate that bolts to the piston. The break occurred in the taper. The fit of the rod in the plate was so close that the piston stuck on to the rod as the engine came to rest, and the rod was lifted out of the cylinder with the piston when it was pulled the first time we looked for the knock. Of course this pounding soon caused wear, so that on pulling the piston this time the rod did not stick in the plate.

The reason for the breakage was evident on comparing the broken rod with the replacement rod ordered from the factory. The new rod has a very little taper and has only one large passage through the center of the rod instead of two for the cooling oil to flow to the piston and return. This single passage is divided by a ¾-in. pipe in its center for the oil to flow to the piston and return through the space around the pipe.

Walthill, Neb. WILLIAM W. DINGWALL.

539. Bronze-welding Bearings.

Shortly after the bearings of an oil engine had become so worn that they were almost useless, an accident broke both bronze main bearings. Naturally, the fracture occurred where the metal was thinnest—at the bottom and top where shims had been used between the back surface and the bearing supports. After the four broken parts had been removed, there was some question as to whether it would be worth while to repair the bearing. A welding operator stated that if a surface of bronze was laid down on the outside of the bearings, there would be ample room for machining and fitting a new inner surface and new oil grooves.

A V was chipped on the broken edges. Then with bronze rod the welder joined the two broken parts and bronze welded the V on the inner surface. The half bearing was then turned over, and the V welded on the other side.

After this had been finished, the outside of the bearing was built up with bronze weld metal about $\frac{1}{4}$ in. This was then machined level. A similar thickness of metal was welded on the outside of the other half of the bearing. The two halves were put into the base again, and the shaft fitted to them.

New York, N. Y. JOHN GOOD.

540. Diesel Engines Can Be Operated with One Piston Disconnected.

In 1923, two four-cylinder, 400-hp. diesel engines were installed in the Port-au-Prince, Haiti, plant of the Compagnie d'Eclairage Electrique, where I was then chief engineer. Load could easily be taken care of by one unit during the day, but at night, from 6 P.M. to 12 M, both engines were required. In starting one engine, a defective starting valve caused bending of a connecting rod, a cracked cylinder liner, and a broken piston. I decided to try to operate the engine on three cylinders until new parts could be procured from the factory, since no stand-by service was available.

The undamaged starting head (engines had but one starting cylinder) was moved to another cylinder, as was the starting cam. The accident occurred at 4 A.M., and emergency repairs were completed at 2 P.M. The engine was started and paralleled with the running machine without difficulty. The results were surprising. The variation of voltage was so small that it could not even be noticed on the lights in the plants. (The generators did not have voltage regulators.) This engine was so operated for 12 days, 6 hr. per day, and carried up to 175 kw.-hr. without trouble.

Osceola, Iowa. H. W. STALNAKER.

541. Device for Truing Engine Crankpins.

Figure 161 shows a hand-operated device for truing an engine crankpin. It consists of two wood blocks with a hole the same size as the crankpin. The blocks are held together by bolts and fitted with handles.

The pin should be covered with oil, a piece of fine emery paper should be placed in the blocks, and the fixture clamped on the pin. Just sufficient pressure should be put on the bolts to make the paper bite the steel. The device should then be turned round to grind the pin.

If possible, the crankshaft should be removed from the engine to enable the tool to be used freely; but if this cannot be done, by shortening the handles it can be used with the crankshaft in position.

Brentford, England. W. E. Warner.

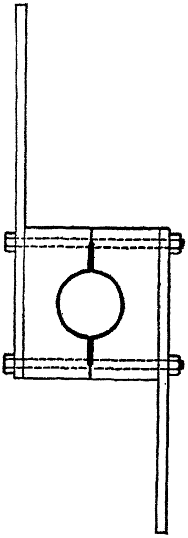


Fig. 161.—Hand-operated tool for surfacing crankpins.

542-543. Installing and Removing Piston Rings.

For placing piston rings, a sheet-steel form is made that is part frustrum of a cone and part cylindrical, as at left (Fig. 162). The cylindrical section is made of a diameter to fit tightly around the piston. It is made open on one side and when in place has a 2- or 3-in. gap.

To put in the rings, the cylindrical section of the form is pushed over the piston to the near edge of the farthest groove and prevented from going any farther by small wood blocks placed in the groove. The ring is then placed on the tapered section and slid up to the far end of the cylindrical section. After removing the wood blocks the ring is dropped into the groove. The form is then moved back to the next groove, blocked into place, and the next ring put into place.

543. To remove the rings, all that is required is five rollers cut from a bright steel bar of a diameter slightly greater than the depth of the groove and of a length slightly less than the width of the groove. One end of the ring is raised, and a roller inserted under it, as at right (Fig. 162). The ring is then rotated so that the roller will roll under it. Additional rolls are fed in so that they will be approximately equally spaced around the ring.

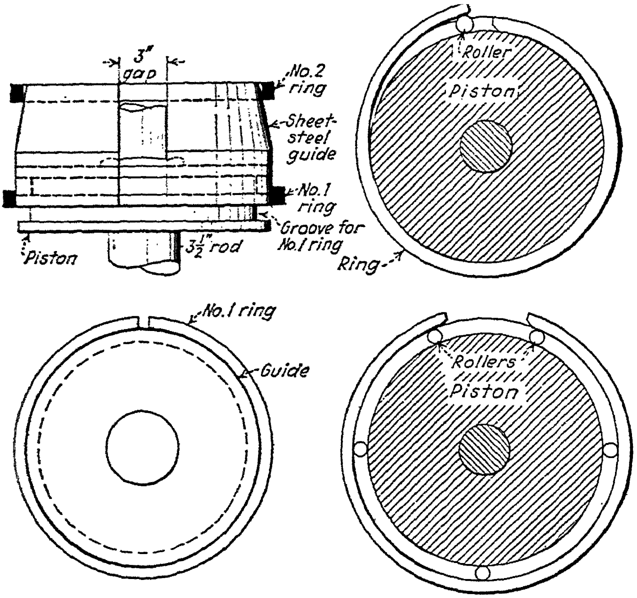


FIG. 162.—Details of piston-ring compressing guide and ring removal.

The sheet-steel guide used to place the ring may now be used to slide it out over the piston.

London, England. J. T. TOWLSON.

544. Testing for Leaky Piston Rings on Diesel Engines.

Leaky piston rings on those cylinders to which air is admitted can be detected as follows: Bar the piston to be tested to the top dead center and by means of a suitably placed lever hold the flywheel in position. Then slowly turn on the air to fill the clearance space but do not open the valve sufficiently to apply full pressure.

After the cylinder clearance is filled with air, if the rings are a good fit, the pressure gage on the air bottle will indicate a constant pressure. If the rings are leaky, the bottle air pressure will gradually fall, and a hissing noise will be heard.

Brighton, England. W. E. WARNER.

545-546. Two Tools for Compressing Piston Rings.

545. The tool shown at left (Fig. 163) consists of a circular ring guard of sheet steel, slightly wider than the piston ring and having small holes, or loops, at the ends. Another tool is then made consisting of two arms pivoted, as shown, and fitted with pins at one end. In operation, the guard is fitted round the piston ring, the pins of the tool engaged in the holes, and the ring compressed by applying pressure to the other ends of the arms.

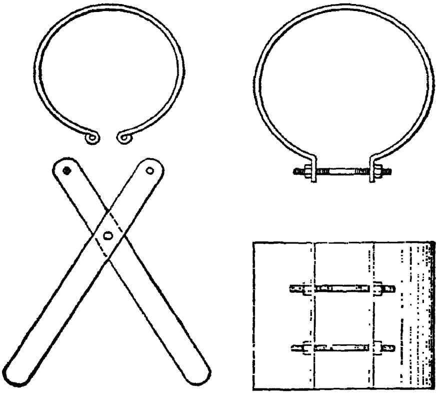


Fig. 163.—Tools for compressing rings.

This will compress the piston ring so that it can be slipped down into the liner.

546. At right (Fig. 163) is shown another useful tool. It consists of a circular guard of sheet metal made the same size as the piston and tightened by the bolts. When the bolts are tightened, the guard will fit snugly around the piston and hold the rings compressed in their grooves. It should be of sufficient length to cover all rings. It is fitted with four feet to stand on the cylinder top. When a piston is being replaced in the liner, it should be lowered until the bottom groove rings are ready to enter the liner. The guard should then be placed around the piston and allowed to rest on the cylinder top above the liner. The two bolts should be tightened gradually and evenly so that rings are compressed in their grooves. The inside of the guard should be kept well lubricated during use.

Brentford, England. W. E. Warner.

547. Ring Bedding.

It is often found after test that rings are not bedded in correctly and may have heavy bearings at the shaded portions shown in Fig. 164. Heavy bearings near the gap can be removed to a considerable extent by relieving the inside face of the rings, as shown in Fig. 164–2. This tends to spread the bearing around the circumference of the rings, and a gastight joint will be obtained more quickly.

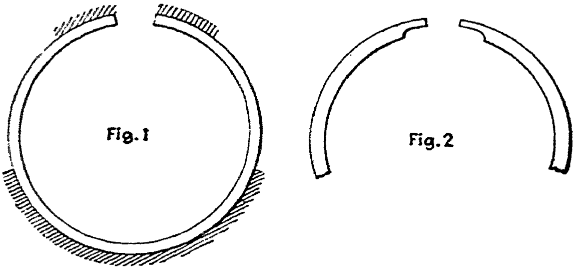


Fig. 164.—How pressure is relieved at ring joint.

Glasgow, Scotland. Douglas P. Muirhead.

548. Gas Engine Cranked by Water Turbine.

A 50-hp. gas engine, direct connected to a 250-volt, three-wire direct-current generator, is started by an 8-hp. water turbine. This generating set furnishes emergency electric light.

When normal electric power fails, a solenoid releases a pilot valve that causes a plunger valve to open, admitting water to the turbine. The water turbine is of the francis type and operates at 3,600 r.p.m. under an effective head of 275 ft. Water is supplied from 25,000-gal. tanks on the roof of the building. For part of the distance up through the building the water main is 6 in. in diameter, and the remainder is 4 in. in diameter.

The turbine is connected to the crankshaft of the engine through a 32-deg. worm drive with a free-wheeling clutch so that the engine is automatically disconnected as soon as its speed exceeds the cranking speed. A system of relays controls the gas valve on the supply line to the engine, automatically opening relays when normal current fails and closing them when normal alternating-current supply returns. The emergency power supply is available within 3 or 4 sec. after a power failure.

York, Pa. J. S. Carpenter.

549. Butted Piston Rings Cause Engine Trouble.

During some preliminary testing, the above engine was allowed to run and get rather hot and was then shut down. When the starter relay was tripped, the water turbine would not start the engine, in fact, would not even turn it over.

Hand cranking was tried, but the engine could not be turned over at all. The engine was allowed to cool, and it started easily. After heating up in normal running, it was noticed that the speed and voltage decreased and the cylinder block became very hot. The engine was then shut down and allowed to cool, after which dismantling showed that the ends of the piston rings had been butted and started cutting. When this was corrected there was no further trouble.

York, Pa. J. S. Carpenter.

550. How Gas-engine-driven Units Were Made to Operate in Parallel.

Speed regulation of two duplicate 75-hp., direct-connected gas engines was for years unsatisfactory when attempt was made to operate them in parallel. Efforts by various operators to adjust the governors was simply a matter of cut and try.

A practical operator was of the opinion that the inability of governing devices to function properly was not the cause of poor speed and hunting when the machines were connected to the same bus.

As a tryout he removed a 2-in. pipe elbow located about 6 in. from the cylinder on the gas line to the engines and put a T in its place. Into the outlet of the T he screwed a short nipple and connected to this an 18-in. piece of automobile tire inner tube. The effect of this attachment was that upon each suction stroke of the piston the rubber tube would contract to about half its size—allowing the right volume of gas to enter the engine—without constriction. The immediate result was almost perfect operation.

Silverton, Colo. Hammond Mathews.

551. Burr on Valves Caused Preignition.

The engineer decided to grind valves on a 50-hp. gas engine. They were removed, and in order to hold them for grinding (there being no slot), he drilled and tapped a hole at *A*, ⅞ in. deep, and screwed in a bolt to serve as a grip for the grinding tool. When the engine was put into service, serious preignition and detonation resulted in a cracked exhaust-valve chamber.

A slight burr thrown up on the valve top when threading had been raised to such a high temperature by the heat of combustion that it caused preignition (Fig. 165). The most practical thing would have been to have rounded the edges of the hole as shown in the detail, as, even if no burr is left, carbon is likely to settle on a sharp edge like this and form a point, which is soon raised to incandescence. If the edge is rounded, the carbon is not likely to form a point but will settle evenly over the surface.

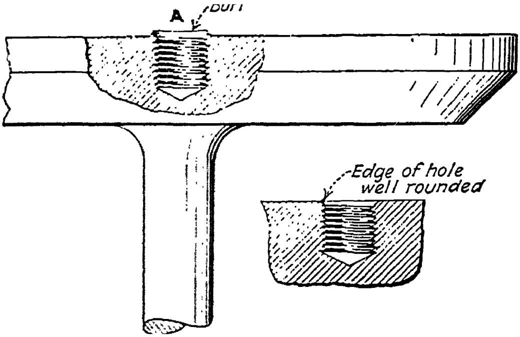


FIG. 165.—Burr on valve (shown exaggerated) caused preignition.

Shefford, England. W. E. WARNER.

552. Effect of High Exhaust Pressure.

We have in our plant an oil engine that has until lately been a continuous expense. Burned-out piston-pin bushings, dirty pistons, and carbon on exhaust ports have been excessive in spite of the best of care, a good grade of fuel, and the best of lubricating oil.

The engine was equipped with a pyrometer and had a thermocouple in each exhaust pipe. Becoming suspicious of this pyrometer, we installed thermometers in place of the thermocouples and found that the true temperature was 125 to 175°F. higher than was considered safe. In looking for the cause of the high temperature, we tested exhaust pressure and found a pressure of 5¾ in. of water in the exhaust conduit. We then removed a manhole cover from the silencer, whereupon the pressure dropped to 2 in. of water, and the exhaust temperature dropped to normal. The silencer was of the wrong design for the engine.

Pompano, Fla. H. C. Cunningham.

553. Fire Caused by Faulty Installation of Semi-diesels.

At a power plant of a certain gold-mining company, two 150-hp. semi-diesel engines were belt connected to air compressors. One windy night in January, a fire broke out at the power plant and was brought under control only with great difficulty.

In determining the cause of the fire, it was found that a wooden box 12 by 14 in. was used on the compressor intakes, which extended outside the wall of the building. The box opening was about 10 ft. from the exhaust of the oil engines, and it was evident that hot sparks issuing from the exhausts of the engines had been drawn into the woodbox intakes, thereby causing the fire.

Butte, Mont. Ralph E. MacKay.

554. Pound in Diesel Cylinder.

Because of its position, the piston-pin bearing is often neglected, and the wear soon reaches a point where the piston jump is taken up with a noticeable knock. Taking up a crankpin bearing is, of course, futile in that case.

To test the piston pin, place the piston on its lower dead center and set a timber across the crankcase main bearing webs. By using a heavy-duty lever jack between the piston and timber, bearing slack can be readily determined, either with a scale or a dial indicator.

Redwood Falls, Minn. Frederick B. Maes,
Redwood Falls Light and Power Co.

555. Why the Engine Cylinder "Missed."

A 120-hp., air-injection, four-cycle diesel on the town's water-supply pumps began to miss. Inspection disclosed nothing that indicated trouble, so the switch was pulled on the water-pump circuit. The engine immediately began to hit on all four cylinders again.

After the engine had cooled down, we put the pumps back on, but after about 30 min. running cylinder 3 began to miss again, and the engine began to heat up. Exhaust was black, showing that the cylinder was getting fuel.

The exhaust valve was taken out of cylinder 3. The valve had been leaking. Clearance had been checked thoroughly, so we knew that that was not the trouble.

The neck of the valve was riding on the guide of the valve cage. This had held the valve open when the engine got enough load on it to expand the valve neck. When some load was dropped, the engine would cool down, and the neck would contract enough for the valve to close, so the engine would then fire on all cylinders.

The valve had not come with the engine, and the refacing necessary to correct its seat had let it come against the guide. We put the valve in a lathe, cut back the neck about ¼ in., and since then we have had no trouble.

Kimball, S. D. ART WILLIAMSON.

556-558. Three Points in Handling Overhead Exhaust Mufflers.

556. Where a gas-engine, direct-driven compressor is used, the muffler is often overhead, with the exhaust piping taking off from the top of the power cylinder and running up through the roof. To keep down the temperature of the room caused by these hot pipes, a jacket is usually placed around the exhaust lines, and a draft is induced whereby the hot gases are dissipated in the air.

557. To stop vibration of the exhaust pipe due to the pulsations of the engine, it is necessary to brace it but at the same time to take care of the expansion. One method of doing this is illustrated in Fig. 166. A bracket is built from the truss of the building so that the outer pipe, or jacket, will rest snugly against it. This prevents vibration of the jacket but does not hold the pipe itself. A spider is built up from this bracket or frame to support the stays for the pipe. On the inner end of the arms of the spider, small pieces of pipe or ¼-in. plate bent to a radius the same as the pipe and about 4 by 6 in. in size are welded. These are passed through slots cut in the outer casing, or heat jacket, and serve to prevent the exhaust pipes from vibrating but at the same time permit of lateral expansion.

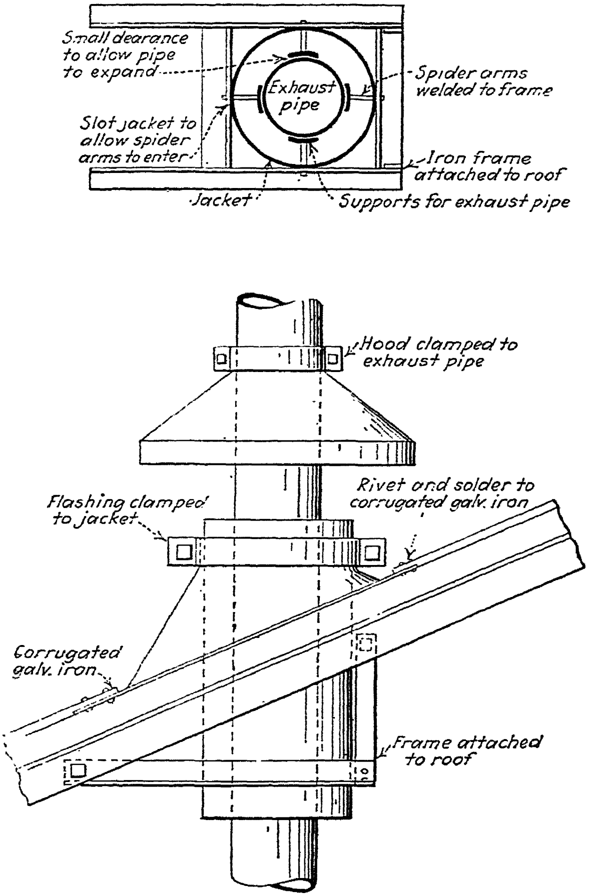

Small clearance to allow pipe to expand
Spider arms welded to frame
Exhaust pipe
Slot jacket to allow spider arms to enter
Iron frame attached to roof
Jacket
Supports for exhaust pipe
Hood clamped to exhaust pipe
Rivet and solder to corrugated galv. iron
Flashing clamped to jacket
Corrugated galv. iron
Frame attached to roof

Fig. 166.—How exhaust pipe is stayed but left free to expand.

558. Where the roof is of corrugated galvanized iron, there must of necessity be a flashing—watertight but not rigid—to allow for expansion. A metal clip is made to fit lightly around the casing, and the flashing proper is then soldered to it. The other side of the flashing, where it goes under the corrugated iron, is held by small rivets before soldering. If it is soldered only, vibration tends to loosen the solder, and water will creep in. The rivets act as a stiffener for the solder.

Long Beach, Calif. M. C. Cockshott.

559. Muffler for Gas-engine-driven Air Compressor.

A piece of 12-in. pipe 6 ft. long was used as a shell, or chamber. At each end, on the circumference, a piece of 6-in. pipe was welded, one for intake and one for outlet. Up the center of the shell a 4-in. pipe had six ¼-in. plates welded on to it at intervals of 8 in. Four 2-in. holes were drilled in each plate, and the plates were staggered on the pipe so that the holes were at 90 deg. to each other. Slots the width of the torch were then cut in the pipe, one in each space between the plates, as shown in Fig. 167.

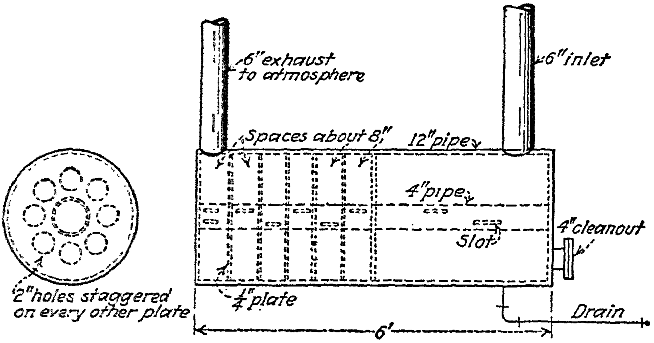


Fig. 167.—Muffler for gas-engine exhaust made from standard pipe.

The whole assembly was then tacked to an end plate and welded to the shell. At the other end a closing plate was welded in. On the intake side of the shell and at the bottom, a 4-in. cleanout flange was welded into a short nipple. A 1-in. drain was led from the bottom into a near-by sump. With this connected up and buried just below the surface, there was practically no noise when the engine was running under full load.

Long Beach, Calif. M. C. Cockshott.

560. Exhaust Connection for Tugboat Engine.

It is sometimes desirable to eliminate the drum-type exhaust muffler for oil engines in dredges and towboats. A means of meeting this situation is shown in Fig. 168.

A casting leads the exhaust into the vertical pipe. Friction is less than with the usual muffler, for the attachment is wider, and the elbow is shaped to give minimum resistance.

Considerable oil and fuel go over into the exhaust pipe and may ignite when the engine is carrying a heavy load. To prevent this accumulation, a 2-in. drainage pipe is provided.

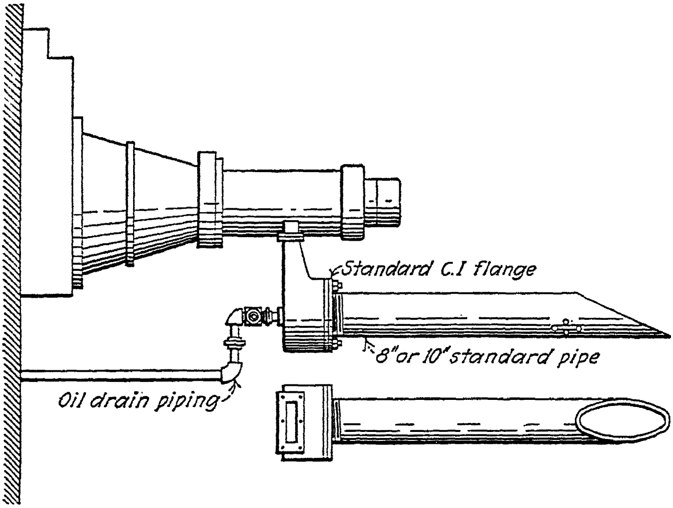


Fig. 168.—Exhaust line for dredge diesel.

This method has been found much better adapted to this kind of engine installation than short pipe and elbows. The shape of the outlet contributes considerably to silencing the exhaust.

Dallas, Tex. Orville Adams.

561. Long Exhaust Line Causes Trouble.

Considerable trouble was experienced with pistons' cracking across the crown on the exhaust port side. The pistons are oil cooled, and the builder suggested that the cooling chamber of the pistons might be coated with carbon owing to a dirty oil cooler's not cleaning and cooling the oil before it was returned to the engine. We cleaned the cooler and checked the temperature of the oil but found that it was well within the range set by the builder. The chambers in the pistons were cleaned, but we still had the same trouble.

After a year of this, electrical demand became large enough to load this unit to its full capacity of 240 kw., which it could not pull. As soon as the load was raised to 220 kw., the engine would start smoking at the exhaust and would go down and out if the load were not relieved. The erecting engineer was sent out to check the engine and found everything in good shape mechanically.

A water rheostat was built, and the engine was tested, but at 220 kw. the engine quit. During the test the pressure in the exhaust line was taken with a manometer and was found to be 4½ in. of water. The gage was attached to the scavenging air line, which also registered 4½ in. of water.

The exhaust line ran along the basement ceiling to the rear of the plant, where the silencer equipped with a 30-ft. stack was located. The total length of the line was 115 ft. with three 90-deg. elbows and two 45-deg. ells.

It was recommended that the exhaust line be changed and shortened by putting it through the roof.

The line as changed measures 30 ft. to the top of the stack. A test was run after the change, and the unit carried 240 kw. for 4 hr. without any trouble. Load was run up to 250 kw., with just a trace of smoke showing at the exhaust. Exhaust temperatures are slightly above those obtained when the engine was on the test floor at the factory, which may be due to a different grade of fuel oil. This is an increase in power of 13 per cent besides the saving of fuel and lubricating oil, as we do not have to run another unit in parallel and only partly loaded. To date, we have not been troubled with cracked pistons.

Walthill, Neb. WILLIAM W. DINGWALL.

562. Smoky Exhaust from Oil Engine.

In our plant, one unit developed a smoky exhaust after two years' operation. We had not changed fuel oil, and the rings were found to be in good shape, so the cause was traced to the spray nozzles, which have a number of fine holes. These holes had become enlarged and were not breaking up the oil.

Cedar Rapids, Iowa. WILLIAM W. DINGWALL.

563. Carbon Monoxide Gas in Diesel-engine Crankcase.

It is a dangerous practice for men to enter the crankcase of a diesel engine as soon as the doors are removed, owing to the possible concentration of carbon monoxide gas in quantities large enough to be fatal.

After removing the doors, a crankcase should be allowed to ventilate for several hours. If time cannot be spared, electric fans or blowers should be placed in one door opening, thoroughly to scavenge the gas from the crankcase. This gas is of an explosive nature, so all open flame lights should be kept away.

If a workman should get an overdose of this gas, one teaspoonful of common baking soda in a glass of water can be given, provided the person is fully conscious. Artificial respiration should be administered if the victim is unconscious.

Walthill, Neb. WILLIAM W. DINGWALL.

564-566. Three Pointers on Regrinding High-pressure Cocks.

564. On a diesel engine of the air-injection type, it frequently happens that one or more of the blowdown cocks starts leaking, owing to wear or erosion from the escaping of high-pressure air.

The method of repairing these valves that has given the best results is simple but effective. The cock is taken apart and reground with a fine grade of compound. The compound is put on the plug part, and the plug inserted in the body and rotated back and forth. At each half turn, the plug is pulled out about one-half its length, then pushed in again, at the same time being given a rotating motion. This prevents grooves from forming.

565. When a grinding compound begins to get dry, put a little gasoline on the plug, and it will take hold again. Pumice stone mixed with oil should be used for finishing. This will put a polish on the plug and insure a more perfect fit. I have used this method on 1,300-lb. pressure cocks and have had no trouble after they were put back into service.

566. One of the most common causes of failures on cocks of this type results from turning them in alternate directions instead of always in the same direction. When a cock starts to leak, operators often try to stop it by drawing the plug tighter into the body, which generally causes it to cut in and does more harm than good. I suggest turning all cocks in one direction only and never attempting to tighten them to prevent leaks but removing and grinding them in properly. If this is done, no more trouble is likely to be had for some time.

Kimball, S. D. ART WILLIAMSON.

567-570. Four Experiences with Pumps and Diesels.

567. On installing a six-cylinder diesel in one plant, the erecting man recommended a centrifugal pump, but the engine manufacturer differed with him, and a triplex power pump was purchased.

Lift varied from 6 to 15 ft., owing to fluctuations in water level in the forebay, so it is probable that a centrifugal pump would have given considerable trouble.

568. When the time came to start the engine, it was felt that the pump should be started first, so the cooling water would be available as soon as the engine was turning over. The water had to go somewhere before the engine valves were opened, and it was a problem to get a relief valve to handle the capacity of the pump and then close completely when the pressure went low enough.

Most of the spring-loaded water-relief valves were to prevent damage to the pump castings, and if they were adjusted so that the pressure would not exceed 15 lb., when the pressure dropped to 5 lb. the spring had so little range that the water continued to flow from the valve. It is probable that a valve with long spring travel could have been designed to operate satisfactorily, but a suitable valve could not be readily obtained.

It was therefore suggested that an old weight-and-lever steam safety valve be used, and, with the addition of a stuffing box around the stem, this worked fine. When the pump was started the pressure rose to about 15 lb., and as soon as the valves were opened on the pipes to the cylinder jackets it dropped to about 7 lb. and remained there. The weight has this advantage: It will keep on dropping until the valve is closed if the pressure goes low enough, which is something that the average spring will not always do.

569. The size of the pump was 4 by 5 in., and it delivered about 110 gal. a minute. A good, if not better, arrangement was suggested at the time. This was to erect a 4-in. standpipe, with the overflow about 12 ft. above the highest point of the engine. This would avoid any undue pressures on the pump or piping, and yet water would be available at any time; and if the valves were closed, the water would run out through the overflow.

570. In another plant, where there were two engines like the first, a pump of the same size was installed and run slightly faster. At that time, the cylinder castings of the engines were so heavy that the builders recommended plenty of cooling water, and it was customary to have it discharge at a comparatively low temperature.

Where the water can run to the pump, the centrifugal type seems to be best.

Cambridge, Mass. G. H. KIMBALL.

571. Inverted Venturi Meter Controls Air Supply.

In testing gasoline engines, it is essential that some sort of metering device be provided for air supply to the carbureter and that provision be made to insure reasonable accuracy over a wide range. Usually, venturi meters are used, but it is difficult to change venturi throats for varying air flows. This difficulty has been overcome at Columbia University by an "inverted venturi." Air flows through straight inlet past a cigar-shaped central element. This element, carrying the lead tube to the manometer, is suspended in the center of the inlet and has small holes drilled through at the throat (its *largest* diameter) to its hollow center. Several sizes of elements are available, to provide for any orifice size desired, and changing them is simple. The device acts as the inlet to the air box, in which is mounted a small blower fan, adjustable in speed to provide the desired amount of air to the carbureter.

572. Two-way Crank Simplifies Taking of Vertical Indicator Cards.

On a diesel engine in the Columbia University mechanical laboratory, a special device is mounted to simplify taking both the normal and the so-called "vertical" indicator cards, which emphasize the combustion portion of the cycle. Since one crank and connecting rod parallels those of the cylinders, it gives a true diagram; the other distorts the combustion portion. Built up of strap iron bolted to the end bell of the generator, the frame of the device carries suitable pulleys for the steel tapes leading to the indicator. The connecting rods lead from the same crank, one vertically and the other horizontally, converting their rotary motion to reciprocating through conventional crossheads.

The steel tapes, or ribbons, leading to the indicator insure greater accuracy due to elimination of stretch and whip encountered with cord. Since both tapes are held taut by springs over pulleys at their opposite ends, it is a simple matter to take the cards in rapid succession, thus avoiding the usual labor of relocating the tape and the danger of changed conditions between cards.

573. Greenish Growths in Cooling Water Prevented.

In cooling-water ponds and the tanks of cooling towers, a greenish growth sometimes occurs. This can be prevented by adding potassium permanganate to the water. One pound of this material dissolved in water is sufficient to treat 1,600 cu. ft. of cooling water. When first added it will turn the cooling water a violet color, which will soon disappear. The treatment will not be harmful to metal parts with which the water comes in contact.

Hertfordshire, England. W. E. Warner.

574-575. Two Cooling-water Problems with Large Gas Engines.

Some years ago, a company manufacturing gasoline from casing head gas decided to put in a central power station and run its several compressing stations with motors instead of individual gas engines, and it fell to me to operate this central station.

574. There were two direct-connected gas-engine-driven units in the station, and the cooling water had to be pumped about half a mile from a river. As the river flowed through the oil country, it was badly contaminated with salt water from the oil and gas wells. This salt did not necessarily hurt the water for cooling, but anyone who has handled large double-acting gas engines, with all their intricate water connections, knows how hard it is to keep all these connections tight, water from a leaking connection usually finding its way into the oiling system. The oil is soon contaminated.

575. The exhaust pipes and manifolds in this plant were water cooled, and as there was always more or less leakage the resultant salt vapor escaping into the engine room and being drawn into the generator windings caused moisture to precipitate in foggy weather to such an extent that it was possible to scrape off large drops from the coils. The trouble finally became so serious that a short circuit developed in one of the machines, and several coils were burned out.

Almost anyone would say that the thing to have done was to tighten up the manifolds and keep the vapor from collecting. But this had been tried. The conditions at this plant were such that it was impossible to keep them tight enough to prevent some vapor's escaping.

One of the electricians finally recalled how a similar situation had been handled at another plant. At his suggestion a gas burner was piped up in each generator pit and kept burning in damp weather. The heat from the burners kept the generators so warm that moisture would not precipitate, thus effectually stopping the trouble.

Coffeyville, Kan. EARL PAGETT.

576. Small Portable Cooling Tower.

A small portable cooling tower capable of handling about 70 g.p.m. of water and suitable for small compressors or gas engines is shown in Fig. 169.

The pond, or basin, is made from 2- by 12-in. by 6-ft. select clear redwood surfaced on all sides, the six bottom boards being grooved to take inserted tongues. The six pieces are assembled with tarred joints. Two inches from the edge of this bottom, and all around, a groove is cut, wide enough to take surface lumber of the same thickness but 12 in. high. The two ends are grooved, and the whole is assembled and bolted to the bottom with ½-in. galvanized bolts. A 2- by 4-in. sill is laid under the ends, and the bolts are made fast through this.

The tower frame is made of eight 2- by 8-in. pieces of redwood sized on all sides. These are cut in 10-ft. lengths and are held together in pairs by corner braces. The posts are placed in the corners of the box and bolted with brass or galvanized bolts. A rail goes around the top of the tower, and two or three decks made from a 2-by-4 frame with builders' laths nailed on them are equally spaced inside the tower. At the top of the tower, a trough built of 1-in. redwood and having serrated edges is made to extend across the center of the tower. Incoming water is piped to this trough.

The louver boards are made from clear 1- by 12-in. redwood, cut to a loose sliding fit between the posts. Cleats to carry these boards are made from 1 by 4's, which gives a finished size of about $3\frac{5}{8}$ in. The cleats are cut at 50 deg. and nailed on the posts sufficiently far apart so that the louvers will slide easily between them. A builder's lath nailed on the back of the post will stop them from sliding through.

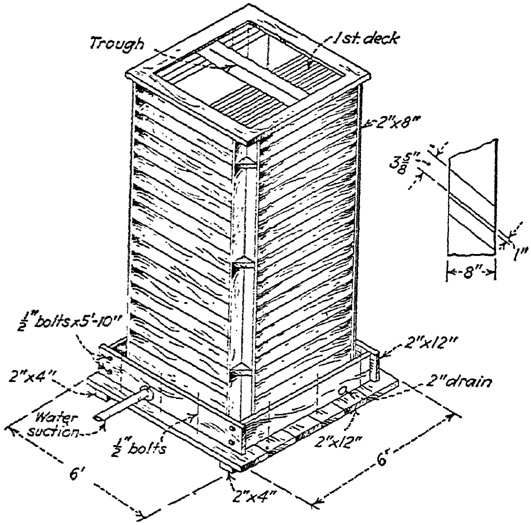


Fig. 169.—Details and dimensions of portable tower.

In the bottom, a flange is bolted to take care of the size of drain needed; also, a flange is bolted on the lower part of the side to be used for the suction line, usually about 3 in. being enough.

This tower will have sufficient temperature range for the average cooling of circulating water for gas engines or compressors and can be increased by passing the water through a spray nozzle. In the installation described, a 2-in. nozzle handling 50 g.p.m. at about 15 lb. pressure would be suitable.

Long Beach, Calif. Maurice C. Cockshott.

577. Cooling Tower for Small Internal-combustion Engine.

A concrete basin 6 ft. square was first built adjacent to the engine room. Walls of the basin were 4 in. thick at the edges, and the floor was sloped from the sides to a point at the center. Over this basin was built a 4-ft. square tower, made by erecting four pieces of 3- by 3-in. lumber vertically and nailing cross-pieces 1 ft. apart. Then racks were built of small pieces of lumber with ¼-in. spaces between pieces. The pieces in each rack run at right angles to those above and below. On top of the tower at the center was placed a 30-gal. wooden barrel. The top head of the barrel was removed, and the upper ends of the staves notched by sawing out small triangular blocks. A 1-in. pipe line then connected the engine water jacket and the bottom of the barrel.

From the basin a drain line, fitted with a screen on the inlet, was run back to the engine, and a small belt-driven centrifugal pump circulated water through the engine jacket and the tower. When the barrel became filled, water ran out through the several notches in the ends of the staves and trickled down the side of the barrel and over the several racks in the tower, where it was spread out thinly and cooled, finally collecting in the basin to be recirculated. The supply of water was readily replenished by pouring more water into the concrete basin.

Cairo, Ga. L. M. JORDAN.

578-586. Nine Facts about Spray Nozzles for Cooling Towers.

578. Having decided on the type, knowing the amount of water to be cooled and the pressures of the water from the circulating pump, the right number of nozzles can be determined. Performance data given in the accompanying table are for the type of nozzle with which I have had the most experience. They are, however, much the same as with other makes.

579. To install the nozzles, the top deck and distributing troughs are removed from the tower. A header of suitable size for the pump capacity is then run down the center of the tower. From this header nipples are welded into it, one end being threaded to take the nozzle, or a made-up header can be bought with screwed reducing fittings.

580. The nozzles are usually placed on alternately long and short nipples, arranged so that a complete curtain of water will be attained.

581. Sometimes additional cooling from an existing tower is required. If the tower is of a standard make, this can be obtained by adding more decks; however, even that will not, in all cases, give the required temperature change. Also, if the tower is of the closed-louver type, it is not always practicable to add more decks. Additional cooling is then obtained by using spray nozzles (Fig. 170). The latter are available in various sizes and types, all of which have their special qualifications.

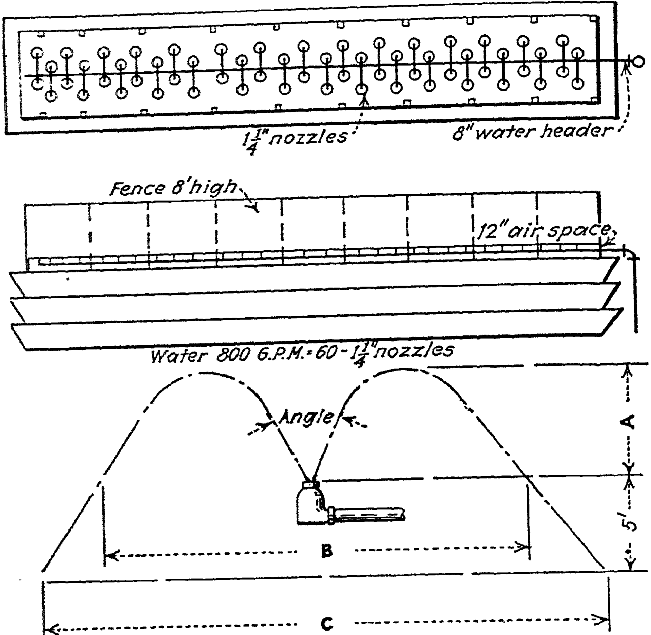


FIG. 170.—Arrangement of spray nozzles at top of tower.

582. A fence, usually about 8 ft. high, is erected all around the top of the tower and held in place by posts spliced to the

SPRAY-NOZZLES DATA

Diameter of nozzle, inches	Pressure, pounds	G.p.m.	*A*, feet	*B*, feet	*C*, feet	Angle, degrees
¾	10	6½	8	14	15	55
1	10	8	8	14	15	55
1¼	10	14	9	13	14	65
1½	12	27½	9	25	26	80
2	9	33½	9	23	24	70
2½	9	62½	9	22	23	70

existing tower posts, with brass or galvanized bolts. The sides are usually of redwood shiplap and should be of select clear wood free from knotholes. A door must be placed at the top of the stairway, also a runway so that access may readily be had to all nozzles.

583. Such spray distribution was first applied extensively to old atmospheric towers where additional cooling was desired. The cost frequently is one-third or less of the cost of building additional tower for the same cooling. If the tower is already highly efficient and delivering cold enough water, the change will not be justified. However, the majority of natural-draft towers are operating on yearly average cooling efficiencies not exceeding 70 per cent. And any such tower will be improved by spray nozzles, although the operating and investment costs must be balanced against the value of the colder water.

584. Spray distribution is today being supplied on natural-draft towers by an increasing number of manufacturers who have realized its value. A number of large operators who have tried it will consider nothing else on new towers.

585. With high-efficiency nonclogging nozzles the normal pressure used for work of this kind is 4 to 5 lb. per square inch.

586. As compared with trough or splash systems, well-designed spray distribution gives improved breakup and distribution of water and increases air circulation, particularly during the periods of low wind velocity, when atmospheric towers are at a disadvantage. The jet action of the nozzles creates air circulation and explains why the addition of nozzles in many actual cases has improved cooling efficiencies from 15 to 100 per cent.

Long Beach, Calif. M. C. COCKSHOTT.

CHAPTER VIII

PUMPS

587. Helps in Packing Stuffing Boxes.

Stuffing-box troubles are among the most prevalent in power plants. Generally, they are not so much due to lack of enduring qualities in the packing materials as to mistakes in using such materials. Some engineers experience trouble with every brand of packing that they select, while others scarcely know what packing troubles are.

Advice as to how the packing should be used comes with every brand available. When such specific instructions are overlooked, trouble is sure to result. An engineer bought what to him was a new brand of piston-rod packing. Without reading the directions, he put the packing to immediate use on his engine. At the end of two weeks, the stuffing box had to be repacked, the first application having shredded out completely. After repeating the operation every two weeks for four months, the engineer read the directions and learned that he had been putting the packing in wrong side up. During those eight weeks, he had been denouncing the packing as utterly worthless.

Common sense and observance of the "instructions for use" are necessary to realize success with any packing. But the packing job is often delegated to men who have scant appreciation of this. If there are any indications of difficulty in removing the old packing, they will jam one or two new rings on top of a set that may have been in the stuffing box for a year or more. If the rod continues to leak, they are likely to draw the gland up until the packing cannot be compressed further. Scoring and irregular wear of the rod follow. Shoulders forming on the rod prevent it from being made tight no matter how carefully it may be packed subsequently.

Besides being bad for the rod, allowing a set of packing to remain in a stuffing box as long as it can be drawn up tightly enough to prevent excessive leakage imposes an extra load on the machine. If it is a pump, the friction thus produced may interfere with pump action. Unequal tightening of the piston-rod packing on duplex pumps is often practiced to make the two pistons travel at an even speed, no thought being given to the added steam consumption and the increased wear and tear.

On the other hand, the blame for stuffing-box troubles cannot always be ascribed to negligence and lack of skill on the operating man's part. Structural defects often are the cause. Sometimes the stuffing box of steam pumps are not centered truly, so that the packing hugs the rod tightly in one half of its circumference and loosely in the opposite half. Or the clearance in the throat of the stuffing box may be excessive, in which case the packing will squeeze through and become jammed between the rod and the wall of the throat, thus wearing the rod unevenly and shortening the life of the packing.

Some operating engineers seem to have small appreciation of the loss due to imperfect packing of the piston and plunger rods of steam pumps. Where the packing is allowed to remain in the stuffing boxes until it becomes vulcanized, clamping and scoring the rods under a heavy gland pressure, the price paid may be heavy. The extra fuel burned is not the only loss. The expense of truing up scored rods and replacing those worn out prematurely is considerable. The steam leaking out of poorly packed stuffing boxes represents another loss; the frequent repackings which damaged rods require also figure up to extra dollars and cents.

Gland pressure on fibrous packing rings causes the rings to expand laterally—out against the wall of the stuffing box and in against the rod. Where the bottom of the stuffing box is beveled, as is the usual practice, and the contact end of the gland also is beveled, a wedging action occurs that causes the rings at top and bottom to hug the rod more tightly than do the intervening rings. For this reason, many engineers require that the bottoms of the stuffing boxes on the pumps that they purchase be bored square with the axis and that the ends of the glands be turned off likewise.

Chicago, Ill. D. J. ALLISON.

588. Pump Suggestions.

I should like to suggest an improvement for valve-stem and piston-rod stuffing boxes to facilitate placing the packing in the box. Chamfer or round the edge of the stuffing box slightly so that neat-fitting packing will more easily enter without pounding and the consequent danger of cutting the outside of the packing ring. Figure 171 will illustrate the idea.

It would also be a big help, it seems to me, to engineers in general, if steam-pump manufacturers would put the following data on the name plate: diameter of the rods, diameters of the stuffing boxes and the depth of them, diameter of the valves, size of hole and thickness of valve, together with the number thereof.

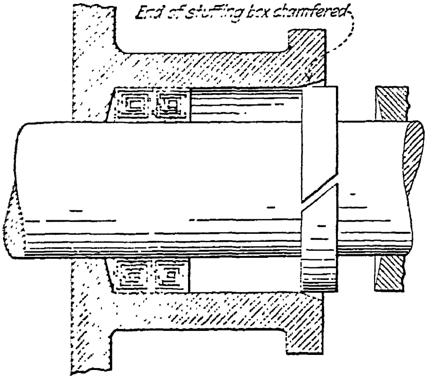


FIG. 171.—Section of stuffing box with chamfered end.

I keep a card record of these details and do not like to take a new pump apart to get this information, but I like to have the correct material on hand to make repairs when needed.

Collingswood, N. J. WILLIAM HEGARTY.

589. Substitute for Pump Plunger Packing.

Steam-driven hot- and cold-water pump piston packing wears out with little warning. This is particularly true when the cylinder becomes pitted.

A good packing substitute may be found in canvas-rubber belting wide enough from which to cut a circle of the diameter of the pump bore. As many circles may be cut as are necessary to fill out the packing space. This belting will not only serve as a substitute but has been found in some cases to outlast standard packing.

Butler, Tenn. W. S. WHITING, JR.

590. Tool for Starting Cylinder Head.

When I was handling the throttles of a 50,000-hp. battleship I used my first homemade device, shown in Fig. 172. It was made by the ship's blacksmith. The idea came to me after I had seen a perfectly good cylinder head of a main feed pump cracked by the indiscriminate application of brawn on a blunt cold chisel with a heavy hammer in an attempt to loosen the head. The little device shown worked splendidly and was used frequently.

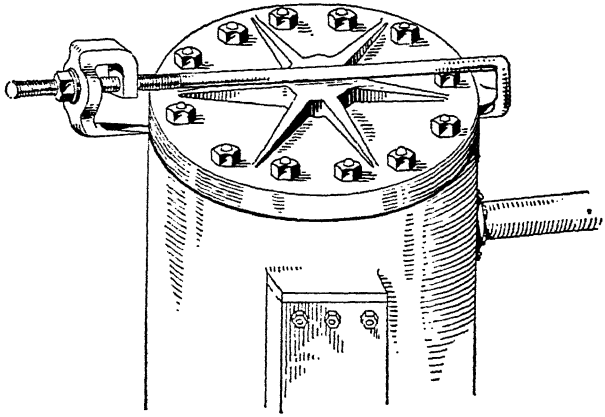


Fig. 172.—Tool for starting cylinder head.

West Concord, N. H. Charles H. Willey.

591. Extension Plate on Pump Valves.

The valve seats on a steam pump wore rapidly because of fine sand in the water. After the seats had been refaced several times, the top of the seat was lower than the deck when the valve was screwed into place. To bring the seat back to its original height, a piece of sheet brass was cut to a diameter slightly less than the over-all diameter of the valve seat. Holes were cut in the brass plate to conform with the holes in the seat.

To attach the plate to the seat, one side of the plate was heavily tinned, as was also the valve seat. Then the two were sweated together, the heating being done by a piece of heavy flat iron heated to a red glow and laid on top of the plate. As the brass sheet was much harder than the seat casting, it resisted the action of the sand much better. When the extension seat ultimately got worn it was unsoldered and reversed or renewed.

Lakeview, Ont. J. E. Noble.

592. Feed Pumps Protect Economizer.

Feed pumps of the outside-packed-plunger type took the water from an open exhaust-steam heater and delivered it through an economizer to high-pressure boilers. Thus the economizer was subjected to the full boiler pressure, and to this fact were attributed occasional occurrences of ruptured tubes. To relieve the situation, the engineer hit upon the plan of substituting a pair of turbine-driven two-stage centrifugal pumps as boiler feeders. From the first stage of each pump, the water was piped to the economizer, through which it was circulated back to the second stage and thence to the boilers. Thus, the economizer had to withstand only the comparatively low first-stage pressure.

Inasmuch as the initial heating of the water in the open heater raised its temperature almost to the boiling point, the heater was set at an elevation that secured a static head on the pump suction of about 12 ft.

St. Louis, Mo. A. J. Dixon.

593. Emergency Repairs to a Pump Piston Rod.

I was confronted with the repair of the piston rod of a mine pump in which a bad groove had been cut by sharp particles of rock in the packing gland. The rod had become so bad that it was difficult to keep the packing in the gland. To get a new rod quickly was out of the question. It was therefore necessary to repair the rod temporarily.

The rod was removed from the pump, and a series of holes was drilled in the bottom of the groove. Groove and holes were filled with babbitt. When the surplus babbitt had been removed, and the rod had been finished true and polished, it gave satisfactory performance.

Butte, Mont. Ralph E. MacKay.

594. Emergency Repairs to Pump Piston Rod.

The article above recalls similar troubles which I encountered aboard ship. However, I should like to warn against drilling into piston rods to anchor babbitt. It weakens the rod, and unless the holes are at varying angles or are of a dovetail shape they do not hold the babbitt securely. And any pump that is subject to severe duty, such as handling gritty water, must, to be even temporarily repaired, have the fill metal well amalgamated to the rod.

Where I have had badly scored water-pump rods handling salt water, I removed the rod and thoroughly cleaned it with acid and scraper to a bright surface. Then I used a heavy soldering copper and thoroughly tinned the surface. Then with a torch and a quantity of best-grade solder I built up layers of solder at the most scored sections, finally having the rod turned to size. Many scored cylinders have been treated the same way.

Concord, N. H. CHARLES H. WILLEY.

595. Repairs to Cracked Stuffing-box Gland.

When serving as a night engineer in a small town, I had a packing gland crack on a feed pump. To reinforce the gland until a permanent repair could be made, two plates of sheet steel were cut as shown in Fig. 173. As soon as the plates were ready, I raised water level in the boiler as high as possible and shut the

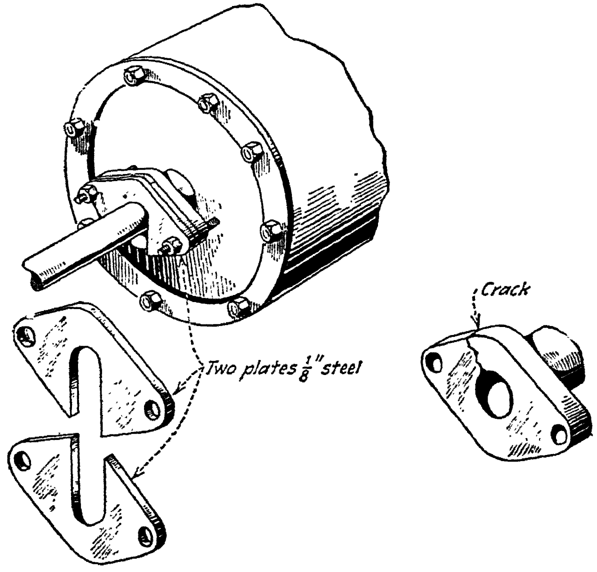


FIG. 173.—How gland was reinforced temporarily.

pump down long enough to put the two plates in place. This reinforcement permitted the packing to be tightened sufficiently to stop the blowing until a new gland could be obtained.

Concord, N. H. CHARLES H. WILLEY.

596. Design of Reinforcing Plate for Cracked Stuffing-box Gland.

Two ⅛-in. plates cut out at one side so that they could be assembled over the pump rod, as Mr. Willey shows, would resist a bending strain equal to only one solid plate of the same thickness, and, in my opinion, a ⅛-in. plate is hardly strong enough for the purpose. I made one plate only, of stock ¼-in. thick, and to get it over the rod I cut it in two as shown in Fig. 174, leaving the plate with almost its original strength. To assemble the plate on top of the gland, I laid one half on first and then let the other half into it. The two halves are thus locked and cannot be pulled apart sideways, and the pump rod prevents their being moved lengthwise. This feature I consider desirable to prevent half of the plate from dropping out if the nuts should loosen a little under vibration.

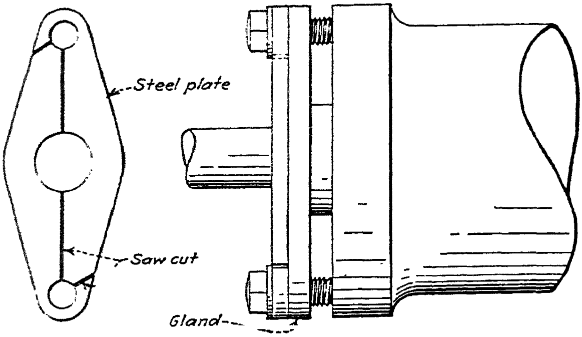


FIG. 174.—Reinforcing plate designed for maximum strength.

Hamilton, Ont. W. H. MOORE.

597. Cone-shaped Collar Facilitates Packing of Water Piston.

On some classes of water pumps, repacking the water piston is rather difficult in getting the proper size of packing on to the piston without tearing or jamming it against the edge.

To overcome this, we made up a cone-shaped collar to fit on the end of the rod against the piston after the follower plate had been removed. The collar, as indicated in Fig. 175, is made with a short parallel section the same diameter as the piston. This section not only serves to guide packing into position on the piston but also permits rings to be fitted and cut to the proper length before the pump is taken out of service.

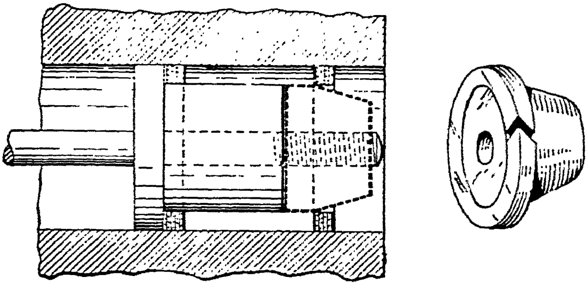


FIG. 175.—Collar in position for packing piston.

Ladysmith, B. C. W. A. COOIL.

598. Keeping a Triplex Pump in Operation While Undergoing Repairs.

A triplex pump was badly in need of an overhauling, and although it was on intermittent service, it could not be shut down long enough to complete the job at one time.

Plungers needed re-turning; crossheads, new pins and bushings; and crosshead shoes, shimming out and re-turning. We decided to do the job one cylinder at a time and to keep the remaining two cylinders in operation as needed.

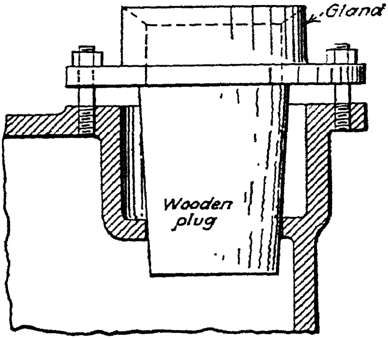


FIG. 176.—Wooden plug used to seal plunger opening during repairs.

To accomplish this, the connecting rod of the cylinder to be worked on was disconnected from the crankpin, and it and its plunger lifted out of the cylinder.

Enough air leaked in, however, to prevent the other cylinders from lifting the water, so a wooden block was turned to fit in the stuffing box, and the gland turned over and tightened down on the plug, as shown in Fig. 176. In this way, the pump could be operated as needed on the two remaining cylinders, and overhauling was much more complete than if it had been hurried.

Coffeyville, Kan. EARL PAGETT.

599. Substitute for Pump Valve Spring.

Several light conical coiled springs over flat rubber water valves were found broken on a pump which was working where new ones could not be procured for some time. Several old automobile seat springs were cut off at a free length, giving about the same compression when under the guide stud as the regular brass spring. The small end was bent in to fit around it under the stud shoulder. They made an excellent substitute, working nicely until new ones arrived.

Missouri Valley, Iowa. F. W. BENTLEY, JR.

600. Repairs to Outside-packed Plunger Pump.

Figure 177 shows how repairs were made to an old-type outside-packed plunger pump. The gland stud holes had been redrilled and retapped numerous times, as the result of abuse or the use of the wrong kind of packing, until it became impossible to renew them further. Angles were bolted to the cylinder to take the studs. Since the repair, the pump has operated satisfactorily.

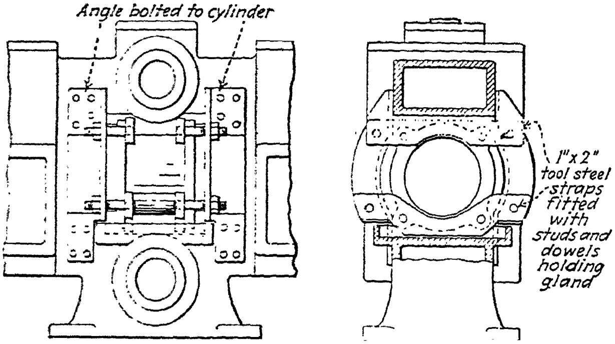

Angle bolted to cylinder
1"x2" tool steel straps fitted with studs and dowels holding gland

FIG. 177.—Angles were bolted to the cylinder to take the studs.

Buffalo, N. Y. C. H. PAEPLON.

601. Emergency Boiler-feed Pump Repair.

A piston rod in a boiler-feed pump broke off in the thread so close to the water piston follower that there was not enough thread left outside the follower plate to get a nut on. Upon removal of the plate, it was found that there was still enough thread on the rod to accommodate one nut if a thinner follower were used.

After some consideration, we decided that it would be much quicker to make a thin follower than to take the old rod out, make a new one, and install it. Accordingly, a thin-follower was made and installed, as shown at right (Fig. 178).

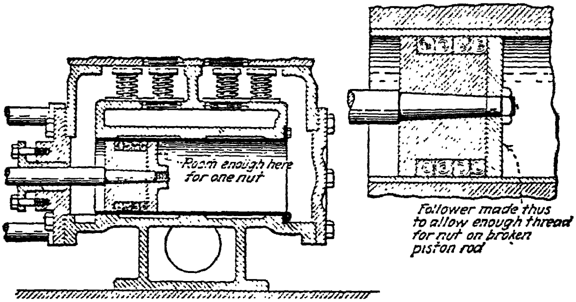

Room enough here for one nut
Follower made thus to allow enough thread for nut on broken piston rod

FIG. 178.—Regular follower plate replaced by thin one to permit use of remaining threads on broken rod.

Topeka, Kan. P. EMERSON.

602. Temporary Repair on Valve Seat Keeps Pump in Service.

One day, a plunger pump in our plant showed a large reduction in capacity by failing to maintain a water supply for one process. The suction-valve seat was found with its threads worn away. It was necessary to get the pump into service as soon as possible.

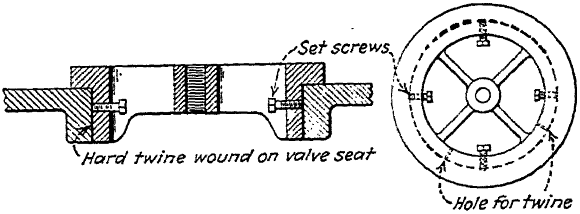


FIG. 179.—Section through valve seat, showing it held in position by screws.

As shown in Fig. 179, the valve seat was tapped for four set-screws. Two small holes that would pass a small hard twine were also drilled through the valve seat, one at the top of the threaded section and another at the bottom. After this was done, a layer of hard twine was closely wound over the worn thread of the valve seat, and its ends passed through to the center of the seat and knotted to hold the twine. The seat was then worked down tightly into place on the valve plate and held there by the setscrews. The pump was operated with this temporary job for about one month and gave satisfactory service.

Detroit, Mich. R. K. MURPHY.

603. Quick Repair for Boiler-feed Pump.

One of the lugs of a valve-operating collar on a boiler-feed pump broke off as shown in Fig. 180, causing the pump to stop.

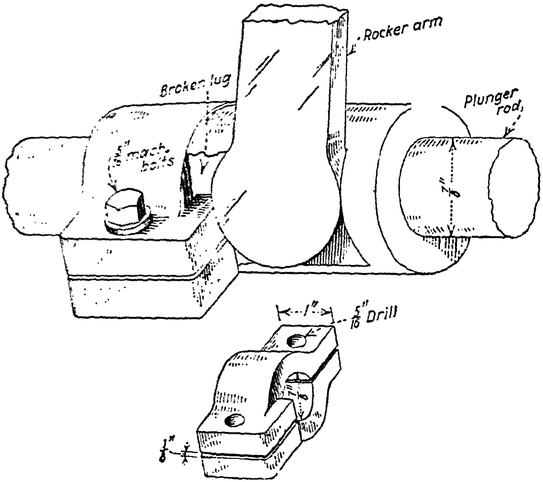


FIG. 180.—Forged clamp replaces broken section of collar.

As the collar was solid and pinned on the plunger rod, it would have been necessary to dismantle the pump to replace the collar.

A quick repair was effected by making a circular clamp as shown and clamping it to the plunger rod. The clamp was made of two pieces of flat iron 5/16 by 1¼ in. It is provided with a projecting lug that bears against the rocker arm and against the cam on the rod. This repair was made in about 1½ hours and caused no shutdown, as the injector was used to keep the water in sight while the pump was down. To dismantle the pump and put on a new cam would have taken several hours at least.

Syracuse, N. Y. H. L. WHEELER.

604. A Self-cleaning Screen for Pump Suction Pipe.

We had trouble on a pump with a 4-in. suction until a strainer of the type shown in Fig. 181 was developed. The top and bottom of the strainer are steel plate with holes in the top for the 4-in. suction and the 2-in. cleaning line. All four vertical sides of the strainer are inclosed in $\frac{1}{8}$-in.-mesh galvanized screen. The screen is supported directly from the end of the suction pipe by four angles riveted to the screen plate and bolted to the pipe. A vacuum gage on the suction line is watched to show when the screen should be cleaned. The cleaning pipe is connected to a water-supply line through a valve. To clean the screen, the valve is opened, and water flows back into the screen box. Because of the bottom plate, the water is deflected and caused to flow out in all directions and carries away any leaves, grass, or other material that may have collected on the screen. Allowing water to flow for 1 or 2 min. is usually sufficient to clean the screen.

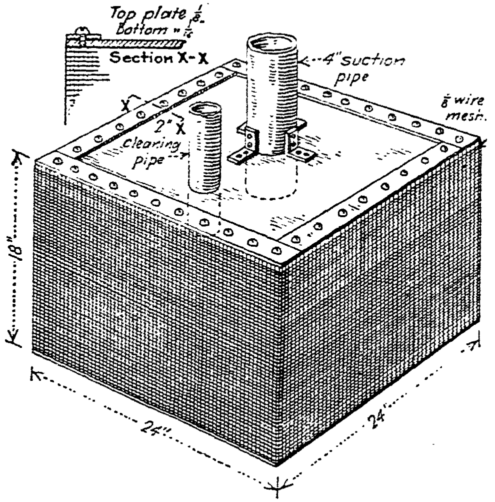


FIG. 181.—Homemade self-cleaning screen for suction pipe.

Cleveland, Ohio. C. A. STEVENS.

605. How to Correct Faulty Suction Lines.

The threaded portion of a foot valve is often short, and unless the suction-pipe thread is cut as short as the foot-valve thread, a portion of the suction pipe will project into the chamber of the foot valve when the joint is made up. This projection will prevent the flapper of the valve from opening as much as would otherwise be possible, thereby decreasing the area of the suction pipe and capacity of the pump and causing an erratic delivery by the baffling effect of the flapper in the path of the water. The projecting pipe often permits the velocity of the entering water to wedge the leather flapper tightly into the suction pipe. Then, if the weight of the flapper is not sufficient to remove the wedged leather from the pipe, it becomes impossible to prime the pump until the leather is reseated.

Another important point in connection with suction lines is to make sure that the end of the suction line is submerged sufficiently to prevent the pump from drawing in air. If a suction line ends a short distance beneath the surface of the water, the velocity of the incoming water will create vortices, or whirls, which will carry air to the pump. The distance that the end of the suction line should be submerged is dependent both on the size of the pipe and the velocity of the incoming water. A safe plan to follow is to have 1 ft. submerged for each inch in diameter of suction pipe for sizes 2 in. and above; sizes above 8 in. may be safely held at 8 ft., except in extraordinary cases.

If this submergence is impossible, a disk three or four times the diameter of pipe, tack-welded around the suction pipe and as close to the end as practical, will prevent air from being drawn into the pump from this cause.

As tight joints are essential in suction-line piping, particular care is required in threading and making up the joints. All pipe machines and stocks have indicating marks for the correct depth of a standard thread. These marks are all right if the thread of the fitting that the pipe screws into is the proper depth—if not, a leaky thread is on the pipe. It is usually more satisfactory, even though more time is required, to take two cuts instead of making the full depth of the thread in one cut. This permits of gaging the distance the thread will screw into the fitting. When threads are cut this way and the joint made up tightly with a metal-to-metal contact, there will be no need of "dope" to produce a tight connection.

Brooklyn, N. Y. WILLIAM ANDERSON.

606. Siphoning Effect Increases Pump's Capacity.

Lulu Island Slough Dyking Commission installed a 60-hp. pump to drain 4,300 acres. It had a rated capacity of 16,000 g.p.m. but delivered 17,000 under test. The outlet was placed at the bottom of the river, and it was found that while the motor used up 50 hp. to start, after a short time the siphoning effect caused by the outlet being under water reduced pump motor load to 31 hp.

Vancouver, B. C. F. H. FULLERTON.

607. Pump Suction Used as Condenser.

On a certain railroad, pumping stations to supply the locomotives were sometimes a considerable distance from the tracks, necessitating a long pipe line. At one station, where suction lift was 24 ft. and discharge head 80 lb., the pump man made a novel suction fitting into which he ran the exhaust from the engine driving the pump. This acted as a condenser, creating an exhaust vacuum of 20 in. Hg, and made a material saving in fuel.

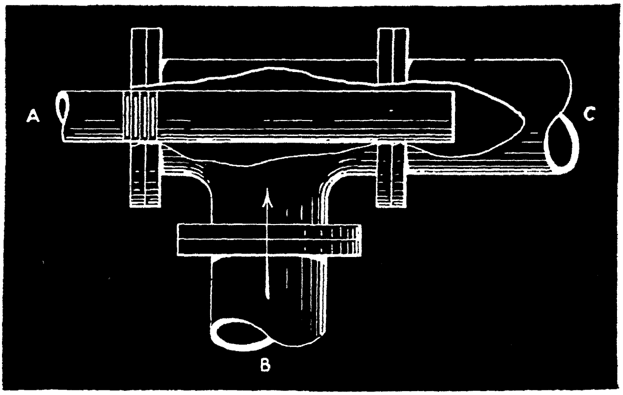


FIG. 182.—Suction fitting which acts as condenser.

The exhaust fitting is shown in Fig. 182. It is important to have the exhaust steam enter at *A*, and the water at *B*. If the water enters on the run, and the exhaust steam enters on the branch, water hammer will probably result.

At the railroad plant, there was no feed-water heater on the exhaust line, the ratio of the steam to water cylinders was high, it being a 14- by 9- by 14-in. pumping engine, and suction lift was high. It costs the railroad not a penny to get 20 in. of vacuum.

C. W. PETERS.

Lawrence, Mass.

608. Uses Ejectors to Prime Pumps.

Figure 183 shows an arrangement that I have used to prime a group of pumps with an ejector. Valves *A*, *B*, and *C* allow priming any one of the pumps without interfering with the others. To prime, say pump 2, open valve *B* and put the ejector into operation. When the pump is primed, water will discharge from the ejector, after which the pump is started.

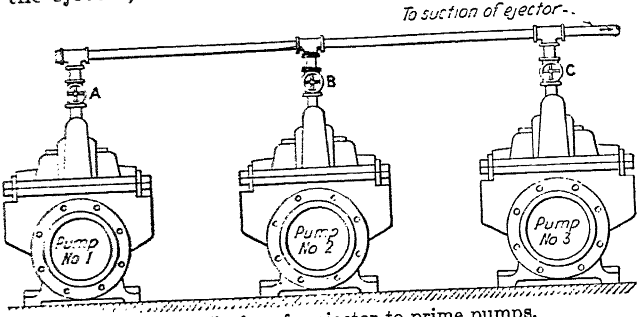


FIG. 183.—Hookup for ejector to prime pumps.

Another method is to connect the priming line to a condenser operating at sufficiently high vacuum to prime the pumps. When this method is used, care must be taken to insure that the valves are closed in the priming line after the pumps are primed. When using this method of priming, I have installed two valves in the priming line to make sure that there would be no leak into the condenser.

LEONARD LONG.

Detroit, Mich.

609. Improvised Pump for Air Chamber.

Here is a method of replenishing the air in the air chambers of feed pumps. To one or both ends of the feed-pump cylinder is attached an ordinary tire valve. These valves, of course, close under pressure but open under suction. Hence, on the suction stroke, a small amount of air will be drawn into the cylinders and discharged to the air chamber on the pressure stroke.

Most automatic pumping systems, such as those in isolated installations, use this method. On small pumps, a single valve would be sufficient, so the cost of installation and upkeep is negligible.

Pittsburgh, Pa. L. G. JONES.

610. Operation of Vacuum Pump Improved by Cooling Coil.

In an industrial plant, trouble was experienced in maintaining proper vacuum on the condensate return system. To lower the temperature of the condensate at the receiver below the flash point corresponding to the necessary vacuum required for proper operation of the low-pressure heating system, cold raw water was added. Addition of this water caused an appreciable heat loss in that it was subsequently wasted by overflowing the boiler-room surge tank. Trouble was also experienced with the boiler feed-water treatment system because of the untreated raw water.

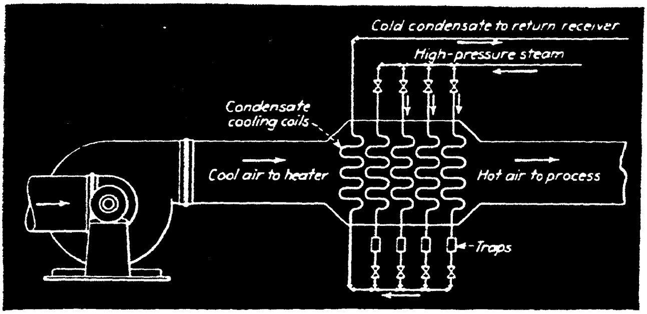


FIG. 184.—Cooling coil lowers temperature of trap discharge.

Traps on a large high-temperature air-heating unit used in a drying operation were discharging into the return receiver. To eliminate as far as possible the cooling water necessary to reduce the temperature in the receiver caused by discharge of these traps, an auxiliary coil was installed in the air heater.

As shown in Fig. 184, the discharge from the high-pressure traps was passed through this coil and cooled sufficiently to avoid further trouble with the vacuum on the low-pressure system. The temperature of the trap returns leaving the coil was low enough to eliminate all the raw water required in the receiver and, in addition, eliminated the heat loss from overflow of the boiler-room surge tank.

Waynesboro, Va. S. H. COLEMAN.

611. Vacuum on Test Gage Shows Dry Pump.

We used a centrifugal pump to unload tank cars. Occasionally, a piece of waste material would lodge in the suction line, which would stop or materially retard the flow of liquid. When this happened, the operator noticed a much higher vacuum on the test gage connected to the suction side of the pump. He then put a vacuum switch in series with the pump-motor starter's line-switch coil and set it for 20 in. of vacuum. In case the suction became closed, the vacuum switch would stop the pump; then the operator would clean out the suction strainer before restarting.

Los Angeles, Calif. P. L. ARMSTRONG.

612. Spare Feed Pump Used to Supply Water for Tube Cleaner.

We were using vertical boilers, and, as usual, the hose leading to the cleaner had to come through the manhole from outside. To use steam to drive the cleaner would make it rather disagreeable for the operator inside, and we did not have compressed air available, so water pressure was our only solution.

We got the water-driven cleaner into action and found not only that we had to use a long connecting hose or run a pipe up to the boiler but that our water pressure was not sufficient to drive the cleaner through the heavy scale at the bottom of the tube.

Something drastic had to be done. Some one suggested hooking on to the feed-water connection inside the drum. Under ordinary circumstances, it would be bad practice to use feed water for driving a tube cleaner, but in this case we fortunately had duplicate feed lines and pumps, so we started up the spare pump and pumped cold water through the duplicate line, adjusting our valves so as not to interfere with the boilers that were on the line.

We obtained the desired pressure, and the operator could control the supply from the inside of the drum, doing away with the man who was necessary to help him when the hose was passed through the manhole. We made up a special fitting for the inside connection and permanently adopted this method of driving the cleaner.

Port Arthur, Ont. R. S. EDWARDS.

613. Interchangeability of Pumps.

Some plants are handicapped by certain valves in inaccessible places as well as by having certain pumps installed so that they can be operated only as independent units.

When the oil engine was installed in the Easthampton Plant of the Long Island Electric Co., care was exercised to arrange the piping and valves so that the two water pumps could be used together or independently.

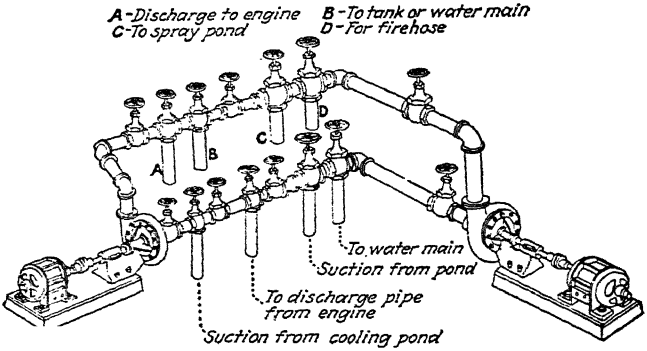


FIG. 185.—Arrangement of duplicate pumps and piping.

The plan adopted finally is shown in Fig. 185. It will be readily appreciated just how flexible this arrangement is and how easily the pumps can be arranged for different operating conditions.

New York, N. Y. J. E. BARRETT.

614. Measuring the Amount of Water Discharged by a Mine Pump.

At one of our mines, a 900-gal. centrifugal pump at the bottom of a 200-ft. shaft discharges water to a 1,200-gal. pump 100 ft. up in the shaft.

The larger pump discharged into a 12-in. pipe going to the top of the shaft and from there in a 45-deg. incline to the crest of an 80-ft. hill, then horizontally 200 ft. to a creek.

The lower pump was operated most of the time with the discharge valve about one-third open or just sufficient to hold the water level at the bottom of the shaft. This aroused a lot of arguing as to how much water was actually being pumped.

Finally, the management decided to purchase a modern pump to be operated at the surface, so they gave orders to find out.

To do this, we erected a wooden tank 8 by 5 by 5 ft. at the end of the discharge line, on which we attached a 45-deg. elbow and a 6-ft. piece of pipe, the end being some inches higher than the edge of the tank.

On the end of the piece of pipe was put another elbow with a short piece of pipe which could be swung to discharge the water into the tank or to the creek. We kept the tank flooded overnight to insure against leaking while testing. By turning the pipe over the tank a few times a day, we could readily estimate the average number of gallons discharged, which in this case was found to be 650 per minute.

Ironton, Minn. AXEL LEKSTROM.

615. One Recording Wattmeter Serves Six Pump Motors.

In our pump department, six pumps are each connected to a motor by a flexible coupling. The pumps are operated under full load and at different pressures, and a record is kept of their performance on a recording wattmeter. Instead of using a wattmeter on each pump, a single meter is made to serve the purpose by connecting it into the circuit, as in Fig. 186. When the double-throw switches are closed to the down position, the pump motors are connected directly to the power source, leaving the meter out of circuit. Throwing any one of the switches to the up position connects that particular motor, through the recording meter, to the power supply.

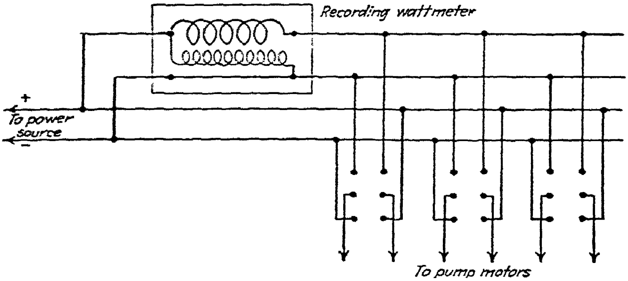


FIG. 186.—Diagram of motor and meter connections.

Chicago, Ill. L. R. BAKER.

616. Electrical Contact Sounds Horn When Pump Runs Dry.

In our plant, there are three centrifugal pumps supplying cooling water to our diesel engines, with a gage to show the water pressure. This gage has an electrical contact that may be set for different pressures. When one side of the twin strainer in the suction line plugs up the pumps, discharge pressure drops, and the gage hand makes contact and causes a horn to be sounded to call the operator's attention. There is also on the same line a pressure-operated switch to energize a magnetic contractor that starts a pump for circulating water through the heating coils in the fuel-oil storage tanks. These switching arrangements could be used to supply current to a relay connected to open the motor circuit and protect the pump from running dry.

Walthill, Neb. W. W. DINGWALL.

617-628. How 12 Centrifugal-pump Troubles Were Corrected.

617. Several years ago, I had occasion to investigate the performance of a particularly noisy centrifugal pump in a large apartment house. When I checked the conditions under which the pump was operating against characteristic curves submitted by the pump manufacturer, I found the actual head considerably less than that for which the pump had been designed. This resulted in higher velocity through the discharge piping and consequent noisy operation.

To eliminate the noise, I reduced impeller diameter so that the pump delivered the volume of water for which the system had been laid out. Power consumption was reduced, and more efficient pump operation obtained. In most cases, a noisy pump is operating inefficiently; an efficient pump, quietly.

618. In another instance, the pump was also noisy, but operating conditions checked with the manufacturer's test curves. Alignment was carefully checked but showed no cause of trouble. After several tests had proved of no avail, we decided to send the pump back to the factory. A mechanic was called to remove the unit. When flange bolts between pump and discharge piping were removed, the flanges separated about 1/8 in., showing that the piping had not been lined up properly with the pump. Correcting this condition eliminated the noise.

619. A new Underwriters' fire pump of an approved make was installed and ready for official test. The pump was rated 1,500 g.p.m. against 100-lb. pressure, but it would not deliver more than 1,100 g.p.m. at the first test, and with each succeeding test the capacity dropped. This indicated a suction-line leak. The suction line was about 200 ft. long, placed 6 ft. underground. We decided to dig up this line, with the understanding that if the suction line was not responsible for the trouble, the pump manufacturer would stand the expense of the work. After the fill had been removed, we found that the line had no leaks but had a considerable hump which provided an air trap and cut down its capacity. When this was corrected, the pump met test conditions satisfactorily.

620. A new 3-in., double-suction centrifugal pump was purchased for use with a water-softening equipment that required 300 g.p.m. against a 50-ft. head. After the pump was erected by the purchaser, it was found that it was about 100 g.p.m. low in capacity. Investigation showed that the pump had a 3-in. suction line about 200 ft. long; as a result, suction lift was about 27 ft. When the suction line was replaced with larger pipe to reduce the suction lift below 15 ft., the pump met the required conditions satisfactorily. If the purchaser had given the pump manufacturer complete information when buying the pump, the trouble could have been avoided.

621. In another instance, a 6-in., 1,000-g.p.m. pump operating under a suction lift of about 18 ft., did not come up to capacity. It was found that the lantern rings in the stuffing boxes had shifted so that the boxes were not being properly water sealed. Air was being drawn into the suction chambers and causing a reduction in capacity. With the lantern rings set in line with the water-seal piping so that water could flow through the stuffing boxes and seal them against air, the pump delivered rated capacity.

622. A 2-in., close-coupled pump with an 11.5-in. impeller having a single shroud extending about halfway up the vanes was installed for handling a fairly viscous liquid. After operating satisfactorily for several months, the pump began to lose capacity and pressure. It was found that the unsupported portion of the impeller vanes had bent back, reducing impeller diameter and changing pump characteristics. To correct the trouble, a new impeller with reinforced vanes was installed.

623. Noise is one of the most difficult troubles to locate in a centrifugal pump. A boiler-feed pump to deliver 500 g.p.m. against 600-lb. pressure was equipped with a balance disk and seat of the conventional type for automatic hydraulic balancing. This type of construction had been used previously on hundreds of pumps satisfactorily. In this one instance, the impellers were made unusually large in diameter due to the low speed (1,450 r.p.m.). This, coupled with high pressures in the pump volute, prevented the balance disk and seat from functioning with their usual smoothness. The balance disk did not find a fixed running position but moved back and forth, alternately opening and closing the space between the disk and seat, and produced an annoying chattering sound and vibration. This trouble was corrected only when the balance disk and seat were replaced by a balance drum of proper design.

624. A centrifugal boiler-feed pump designed for 1,500 g.p.m. against 400-lb. pressure at 1,750 r.p.m. broke its shaft after about 800 hr. of operation. After we replaced the shaft, tests showed that because of the volute design there was a steady downward pressure on the shaft during operation, which flexed it and caused it to crystallize and break. A larger shaft would have corrected the trouble, but this would have required changing all impellers and internal parts. Rather than do that, the pump manufacturer designed a new case with a double volute to fit around the same rotating element. In this way, pressure was distributed uniformly around the shaft and prevented any further shaft trouble.

625. As a rule, when an operating engineer discusses the efficiency of a centrifugal pump, he thinks principally of impeller-vane and case-passage design, elements which are under control of the manufacturer. Too often he forgets that proper alignment of the unit, amount of wear in impeller and case rings, and tightness of packing in stuffing boxes have a considerable influence on the power required by the pump. Recently, I found that the efficiency of a 4-in., double-suction pump could be raised almost 4 per cent by loosening the stuffing-box packings and yet maintaining the packing tight enough to seal against air leakage into the suction chambers. By removing all but one ring of packing from the stuffing boxes and filling the space with a stiff grease, efficiency was raised another 2 per cent. The grease served as a satisfactory seal against air leakage into the suction.

Improvement in efficiency will vary with different sizes of pumps and will depend upon conditions under which they operate.

626. In another case, it was found practical to change the type of wearing rings and provide them with an annular groove into which grease could be packed from outside while the pump was in operation. This reduced leakage between discharge and suction chambers and increased the efficiency several per cent. Clearance between the casing and impeller rings will normally permit a fairly large volume of water to pass, owing to difference of pressure between suction and discharge. Anything done to reduce this loss of water without increasing friction will raise the efficiency.

627. Many centrifugal pumps are installed with an elbow directly at the suction. Where space conditions permit, a straight run of pipe should be provided between the suction elbow and pump suction to smooth out the liquid flow before it enters the pump and thus improve efficiency. It is always best to have the water or other liquid enter the pump suction as smoothly as possible. An attempt to insure this type of setting is seen in modern pumps where the suction nozzle has been lengthened considerably.

628. In a large chemical plant, a 3,000-g.p.m. pump operating against 150-ft. total head had been working satisfactorily for over five years. After two new shaft sleeves were installed, it was found that the pump capacity dropped off over 10 per cent, although the power consumption was about the same as before the change was made. Investigation showed that the shaft sleeves were not tight on the shaft and air was leaking into the suction chamber under them, thus reducing capacity, pressure, and efficiency. When the shaft-sleeve hubs were counterbored and the spaces filled with shellac, air leakage was stopped, and the original rating and efficiency were obtained.

New York, N. Y. FRANK A. KRISTAL,
Mechanical Engineer.

629-631. Three Pointers on What Causes a Centrifugal Pump to Lose Its Prime.

Why does a centrifugal pump lose its prime? This question and the answers afford a variety of conjectures. Unless the water is hot, a centrifugal pump loses its priming only by getting airbound.

When the prime is lost, test as follows:

629. See that the foot valve is tight. Then take it off and put a cap on the end of the suction. Let the water under pressure come back into the suction or connect the pipe with a water or compressed-air line. Go over each joint in the suction and examine for leaks.

630. If compressed air is available for testing for leaks, paint each joint with soapsuds and watch for bubbles. If water is used, add a little ammonia to the water and test any suspicious places with phenolphthalein paper (which can be had at any refrigerating plant or dealer in ammonia or refrigerating supplies). If leaks are located, calk them with candle wicking soaked with white or red lead in oil. Should this fail, look at the stuffing box when the pump is operating at full speed. Make sure there are no leaks through the packing.

631. Automatic priming equipment can be installed on the pump, but I have found a simpler device very satisfactory. Remove the pet cock at the highest point on the pump casing, insert a short nipple, and connect a vertical check valve *upside down.* In this, insert another nipple and an ejector, connecting the smaller opening to a water or air line under pressure. On opening the valve leading to the ejector, any air or vapor is sucked out of the pump, but when the water follows it, the vertical check is lifted, and the device becomes inoperative. A large pump creates more or less turbulence around the entrance to the foot valve, and air may be drawn down through a foot or more of water. The remedy is to make the suction deeper.

St. Louis, Mo. L. R. BAKER.

632. Correcting Centrifugal-pump Difficulty.

In some types of centrifugal pumps, the stuffing box uses a lantern or water seal. Pieces of packing, dirt, and sediment gradually collect in the water-sealing ring or lantern, settling at the bottom, and in time may completely fill it up. When this occurs, the inlet of the water-sealing line is invariably stopped up. Then the packing runs dry. The pump may take air in through the packing or may cause overheating and possibly burn out the packing (on a high-speed shaft).

By drilling and tapping a hole in the bottom of the stuffing box directly under the water-sealing line and adding a valve, this trouble can be eliminated. Once every few weeks, this valve should be opened for several minutes, and the ring flushed.

633. Trouble with Centrifugal Pump Caused by High Speed.

I was called to a cannery where a new centrifugal pump had just been installed. The pump was on a dock close to the water, and the motor on a staging 6 ft. above the pump.

The complaint was that "the pump" wasn't "delivering enough water," that it was running warm, and that it was impossible to keep the proper size of fuses in the motor circuit.

I checked the motor and found nothing wrong electrically. Then I looked over the pump and found that the same size of pulley was on the pump as on the motor; consequently, the pump would run practically the same speed as the motor, which was 1,740 r.p.m.

The only solution was to cut the speed of the pump down to 900 or 1,000 r.p.m.

Acting on this suggestion, the management had a countershaft installed with the proper-size pulleys to reduce the speed of the pump to around 1,000 r.p.m. At this speed, the pump appeared to do what was expected of it.

Butte, Mont. RALPH E. MACKAY.

634. Vibration in Centrifugal Pump.

A centrifugal pump was bought from a used-machinery house at a bargain and installed. After it was started, pumping head was lower than expected, and the pump vibrated excessively. Inside the casing was a large, heavy casting fin that had no reason for being there. The fin had to be chipped out by hand. Then the engineer realized why he had acquired the pump so cheaply.

After the fin had been chipped out and the inside sandblasted, it was painted with two coats of an enamel which dries hard and smooth and put back into service. There was no more vibration, and the pump operated satisfactorily.

Hanover, Pa. JOHN S. CARPENTER.

635. Operating a Centrifugal Boiler-feed Pump with Throttled Discharge.

Our night load gets very light, and we have to change to a smaller boiler-feed pump; then we must throttle the pump down to keep 450 lb. pressure on the feed line at the boiler. We obtain this pressure by throttling the discharge valve. Not long ago, the pump was taken down for inspection, and it did not show any signs of wear from being operated with a throttled discharge.

The pump is a 600-g.p.m., double-action, horizontal centrifugal unit embodying the Jeansville pattern. It is fitted with a bronze-covered steel shaft, bronze impellers, and bronze diffusion vanes and is connected direct through a flexible coupling to a four-pole, 250-hp., 1,800-r.p.m. synchronous motor. It has been our experience that throttling the discharge does no harm to the pump so long as sufficient water is discharged to carry away any heat generated.

Beaumont, Tex. ROBERT F. CLARK.

636. Keeping Water Out of the Bearings on Centrifugal Pump.

In a centrifugal pump, the water-packing gland is usually within a few inches of the thrust bearing on one end and the main bearing on the other. Considerable trouble is frequently had from water's creeping along the shaft and into the bearing, causing the oil to float out.

We overcame this trouble by cutting an old leather hydraulic elevator valve cup to fit the shaft snugly. The cup was cut down one side to the center and slipped over the shaft with the flange toward the water seal. The joint was then laced with wire, and the cup pushed close to the packing gland. Any water leaking from the gland is now thrown off before reaching the bearing.

Buffalo, N. Y. A. D. MEAD.

637. Plunger and Broken Rod Fished Out of Deep Well.

We broke a coupling on the inside rod that supports the lower plunger of our power-driven deep-well pump, and the plunger went to the bottom of the working barrel, 99 ft. down. This plunger is 9.75 in., and the coupling broke at a point 20 ft. above, so we had to fish plunger and rod out by grabbing the end of the

2-in. rod with enough grip to lift the 20 ft. of rod and the plunger as well as the weight of the water.

We made a tool like that in Fig. 187. It had an opening of 2.25 in. diameter, and the clamp was 3 in. long, with a strap screwed and welded to each side, and the two upper ends welded to a nipple of $1\frac{1}{4}$-in. extra-heavy pipe, so we could use pipe of that size for our pull rod. The eccentric is a little over 2 in. in diameter, with a 0.75-in. bolt to resist shearing. The face is notched and casehardened. In the side, we cut out a notch and then drilled and inserted a small eyebolt so the eccentric could be rolled over to take hold.

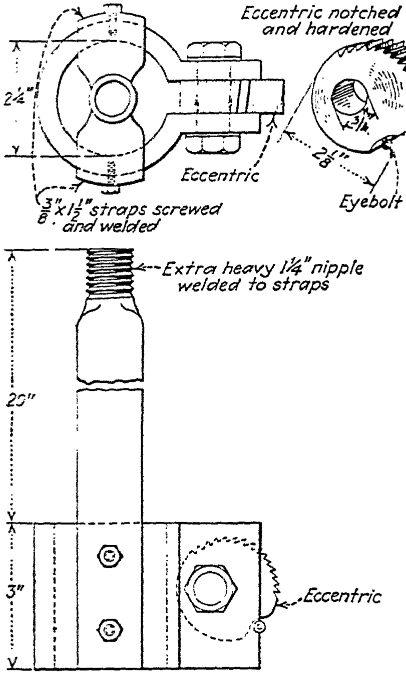

Eccentric notched and hardened
2¼"
Eccentric
3/4
2 5/8"
Eyebolt
3/8"x1½" straps screwed and welded
Extra heavy 1¼" nipple welded to straps
20"
3"
Eccentric

FIG. 187.—Grappling tool used to remove broken plunger rod from well.

Before lowering in the well, we fastened a funnel of 18-gage sheet metal to the clamp so it would easily center on the rod when we reached it, and on the first attempt we clamped the rod and lifted out.

South Bend, Ind. F. R. SWINK.

638. Bailing Pump Made from Pipe and Fittings in Emergency.

Around power or manufacturing plants, there is occasional need for a bailing pump. A practical and readily made hand pump, put together to clear a flooded boiler room, is shown in Fig. 188. This pump is made almost entirely of pipe. The foot valve contains a simple leather flap valve. The piston is fitted with a leather facing and weighted closing valve.

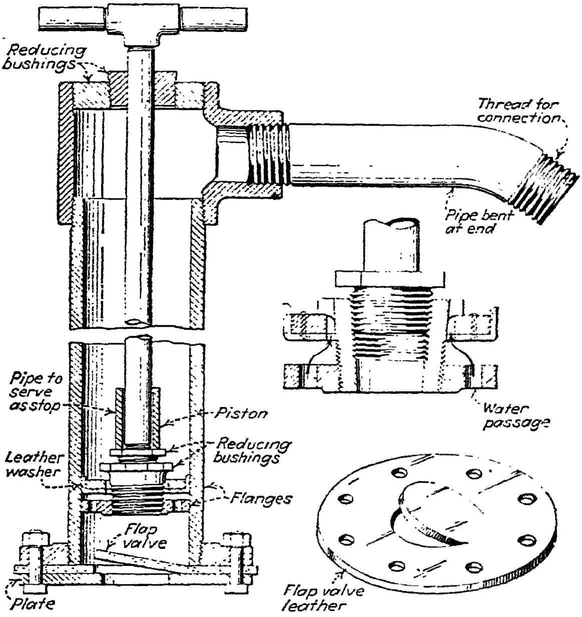


FIG. 188.—Assembly and detail of hand pump.

Washington, D. C. G. A. LUERS.

639. Reclaiming Air-lift Pipe.

One hundred and sixty feet of 3½-in. delivery pipe, with an equal amount of ¾-in. pipe clamped to its side to supply air pressure for raising water by means of the air lift, was being lowered by means of a chain block into a well 365 ft. deep with a 6-in. casing. The chain hoist broke and allowed the pipe to drop and come to rest with its top end 195 ft. from the surface.

A device which would go inside the 3½-in. pipe was constructed as shown in Fig. 189. A wire cable was attached to its upper end, and a windlass was arranged at the well top for hoisting the pipe.

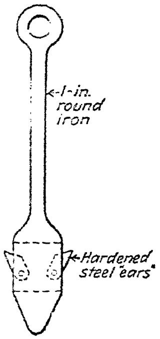


Fig. 189.—Device for reclaiming air-lift pipe.

The tool was lowered and "fished" around until it entered the pipe and dropped below a coupling. Then it was drawn up, and the hardened steel "ears" opened into the space between the ends of two lengths of pipe. The pipe was successfully raised.

North Plymouth, Mass. C. B. Hudson.

CHAPTER IX

AIR COMPRESSORS

640. Maintenance of Air Compressors.

The usual air compressor is a two- or three-stage machine. One important thing in operating a compressor of this kind is to watch the readings on the pressure gages between the stages, for if any unusual change takes place it should be investigated at once, as it denotes leaky valves or piston rings either in that stage or in the one above it.

Leaky valves and piston rings may be caused by air containing abrasive impurities. This makes it advisable to fit filters over the air intake.

In some cases, valves and piston rings in the low-pressure cylinder may be unaffected, but those in the intermediate- and high-pressure cylinders badly scored. The cause is not impurities in the air as it enters the cylinders but impurities collected in the compressor. Steel and iron parts may rust owing to moisture collected from the air, the loose rust being carried away with the air and scoring metal surfaces in the succeeding stages.

A place where rust is likely is in steel purge chambers between stages. The best remedy is to paint the interior with a good metallic enamel.

Proper lubrication is most important. A poor oil may cause considerable trouble from excessive carbon formation in cylinders and intercoolers. In some cases, in order to reduce the amount of carbon formed, lubrication with soapy water is adopted after the compressor has been started, oil lubrication being reverted to about 1 hr. before stopping, to avoid trouble from water in the compressor. The soapy solution is made from about 1 gal. of soft water to 2 lb. of soft soap. While this solution is being fed, the drain cocks should be opened frequently to drain away any water and sludge.

Intercooler coils occasionally fail by bursting. This is sometimes due to an oil explosion in the coils and reduction in their strength by erosion and corrosion. The coil is weighed every six months, and when a weight reduction of 30 per cent is reached, the coil is discarded. The coil is of course cleaned before weighing.

By avoiding overheating the compressor, using lubricant sparingly and removing solid impurities from the air by filtering, the life of these coils can be lengthened, and liability to failure by bursting materially reduced.

Brentford, England. W. E. WARNER.

641. Cause of Wear in Air Compressor.

The high-pressure cylinder of a three-stage compressor showed signs of severe wear, the liner walls being scored, and the piston rings and valves becoming pitted and worn in a short time. Examination disclosed rust. Its source was the intermediate-stage scale trap.

The rust, carried along with the air, had acted as an abrasive. The trouble was remedied by thoroughly cleaning the inside of the trap and painting it with a pigment made from 3 lb. of flake iron and 1 lb. of linseed oil which had not been treated with a drier. An additional precaution was keeping the traps well drained.

Brighton, England. W. E. WARNER.

642. Increasing Capacity of Air Compressor by Heating the Discharge Pipe.

We were using a heavy paving buster to remove an old foundation. Air was supplied by a small motor-driven compressor rated to deliver 38 cu. ft. of air per minute at 100 lb. This was not sufficient to keep the hammer in constant operation without an undesirable pressure drop. Moreover, the weather was cool and damp, and air, coming from the receiver through 150 ft. of pipe, was already so low in temperature that, upon reaching the hammer, the additional drop in temperature due to expansion caused freezing of the water vapor carried by the air in the exhaust ports. We built around the air pipe near the hammer a fire to heat the air to a temperature as high as the connecting hose could well stand. This prevented further freezing of the moisture. Another benefit from the heating was an increase in volume of about 20 per cent, equivalent to increasing compressor capacity.

Lake Charles, La. M. F. KNOY.

643. Grouting with Molten Metal.

I was supervising installation of a large duplex air compressor, direct connected to an engine-type direct-current motor. The unit was to be mounted on a foundation fabricated from structural steel which rested on piles supporting the compressor house. The space between compressor frame and foundation was to be grouted with antimony lead, or "type metal."

As work was in progress in December in an unheated room, with temperatures below freezing, naturally the compressor bedplates and steel foundations were cold, and although the type metal was heated to almost white heat, it would run under the compressor frame only about $\frac{3}{8}$ in., then chill, shrink, and set almost as soon as it was poured. It was inadvisable to heat the compressor frame or foundation, because of possible cooling strains, as only a small portion could be heated effectively at one time.

We built up a dam of wet clay around one side of the frame. Type metal was then heated as hot as possible. Kerosene was poured under this side of the compressor frame and ignited, and as soon as this first amount was burned, additional kerosene was poured in and ignited. Immediately after the second kerosene had burned out, another pouring of kerosene was made, and the red-hot type metal was poured into the gates at the several points provided for it.

The kerosene was ignited by, and burned ahead of, the molten type metal, giving just enough heat to keep the metal molten until it had penetrated under the compressor bedplate nearly to the center, the heat being supplemented, of course, by the small amount of heat absorbed by the previous burnings of the kerosene. These heatings removed the chill from the bedplate and steel foundation without heating them dangerously.

By grouting one side at a time, we got a good job. After a year's continuous operation, the grouting is still intact and solid, even though the whole compressor house vibrates considerably.

Boston, Mass. J. W. Reynolds, Jr.

644. Old Foundation Enlarged.

Some time ago, we were obliged to install a new air compressor without time to build a new fundation of the required size. We decided to enlarge an existing foundation block to the proper size by adding concrete to each side. The old bolts were first cut off flush with the top of the old pad. Then grooves were cut in the concrete at the bolt locations for the new machine. Loop bolts threaded on the top end were placed in the grooves and held in place at the top by wooden templates.

A form was then built around the pad to the required base plate size. The old foundation had been cleaned of all oil and well roughened up to insure a good bond.

The form being set, space between it and the old pad was filled with quick-setting cement. Care was taken that the end excavation made for the loop bolts was well filled with grout, so that it spread out and made a firm bolt anchorage.

Long Beach, Calif. M. C. COCKSHOTT.

645. Intake Screen for Air Compressors.

We believe that long, and especially high, intake pipes, when properly sized, have advantages other than giving comparatively clean air. Air at that level is cooler, and this adds compressor capacity. Again, the pressure, owing to the motion of the air in the long pipe, causes the intake valves to open a little earlier and the cylinder to fill a little fuller.

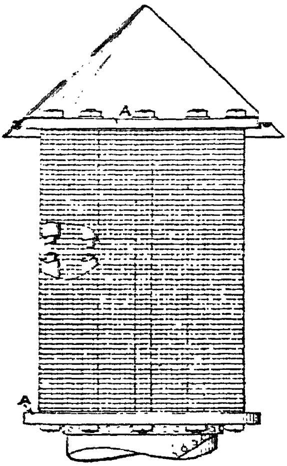


FIG. 190.—Type of screen used on spiral-riveted air-intake pipe.

Figure 190 shows the head on our intake air pipe with half of the cone-shaped cover removed. The two flanges *AA* are separated by 1-in. pipe spreaders, and around these spreaders is wired a sheet of No. 12 brass-wire cloth with ½-in. mesh. Under the nuts on the upper flange are short bent pieces of 1½- by ⅛-in. iron, and to these the top is bolted.

Elgin, Ill. L. P. WILBUR.

646. Slamming Air-compressor Valves.

There was not room for the receiving tank in the same building with the compressor. It was therefore placed about 45 ft. distant and connected by underground piping. When the compressor was started, the valves slammed badly owing to excessive air-pressure pulsations in the pipe. These pulsations increased with the length of the pipe between compressor and receiver and also with compressor speed.

To reduce the intensity of the pulsations, we obtained a piece of 14-in. pipe about 4½ ft. long and threaded and capped it at both ends. The caps were tapped eccentric to the air-pipe size. This piece of pipe was then put into the underground run of air pipe about 5 ft. from the compressor in such a manner that it would drain in the direction of flow. Slamming of the valves was completely stopped. This compressor had positive intake and disk discharge valves.

Chicago, Ill. P. L. Williams.

647. Intake Screen for Air Compressors.

Figure 190, on page 348, does not protect the intake pipe from driving rain. I have installed and used a number of screens like Fig. 191 that have proved satisfactory. Sections are cut out of the pipe either with a torch or by drilling and chipping, each section equal to twice the area of the pipe. The cover can be made from a discarded oil drum. I should not recommend a high suction pipe except in certain cases. I believe in using as short an intake as possible, with due consideration of the advantages of cold air and avoiding tampering with the screen.

Hule, Oaxaca, Mex.
E. W. Heinrichs.

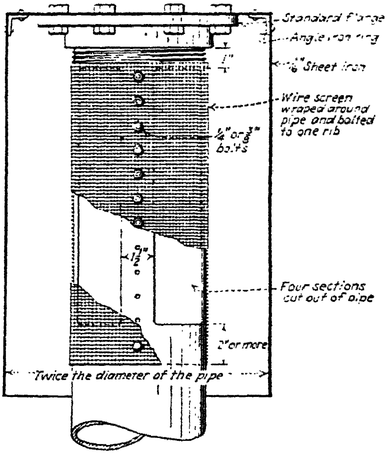

Standard flange
Angle iron ring
1"
1/16" Sheet iron
Wire screen wraped around pipe and bolted to one rib
1/4" or 3/8" bolts
1/2"
Four sections cut out of pipe
2" or more
Twice the diameter of the pipe

Fig. 191.—Intake screen with sheet-metal cover.

648. Why the Air-compressor Belt Flapped.

A certain company experienced trouble with the belt connecting an air blower to the driving pulley of a single-cylinder diesel.

The belt seemed to pass through regular cycles of flapping and running smoothly. Alignment of the two pulleys was correct.

Compressor and engine were designed to run at the same speed. They had pulleys of the same size in order to give this relation. Of course there was some slip in the belt. Since both machines were single-cylinder, every little while the slip in the belt would allow the piston of the compressor and the diesel piston to get into such relative positions as to cause alternate load and no load on the belt connecting them, hence the periodic flapping.

This difficulty was quickly corrected by changing the engine pulley for one a little smaller. This caused the compressor to run a little slower, but it worked satisfactorily, and pistons did not stay in any relative position long enough to cause the belt to flap.

Orange, Tex. R. F. Sorrells.

649. Oil Ignited in Oil Separator on Air Compressor.

A four-stage air compressor delivering air at 1,430 lb. pressure burned a bend in the pipe just beyong the stop valve on the discharge side of the oil separator. Examination showed that the metal of a bronze bushing and the copper ring on the stop valve had been previously melted by overheating due to temporary failure of the cooling water and ignition of the oil on the separator walls. After this accident, these safety precautions were taken: better supervision of cooling-water pressure and measurement of delivery-air temperature by recording instruments. The delivery valve is tested for leakage, and the oil separator cleaned at regular intervals to remove any oil film.

Hertfordshire, England. W. E. Warner.

650. Air-cylinder Lubrication.

Each cylinder should be equipped for forced-feed or pressure lubrication whereby uniform and measured quantities of oil can be fed regularly; in the first stages, only a drop or two a minute will be necessary. The third, or last, stage will usually be abundantly served with oil carried up from preceding stages. But no hard-and-fast rule can be laid down. The safest course is to remove the valves at periodic intervals and examine the cylinder walls. A properly lubricated wall should be coated with a film of oil which will just barely dampen or stain a cigarette paper.

651. Air Compressors Operated Outdoors in Cold Weather.

While visiting a hydro project under construction, I noticed on the air compressors an attachment for warming the oil that is applicable to similar installations. The compressors had a temporary roof built over them for protection from the weather, and it was desired to insure proper lubrication during very cold weather.

They were two-stage, the cylinders being lubricated by a mechanically operated pressure lubricator. Connecting rod bearings and crossheads were lubricated by splash. Three lines of ⅛-in. copper tubing were run from the high-pressure air discharge. Each line of tubing was provided with a shut-off valve, one line going to the high- and one to the low-pressure connecting-rod well. At the bottom of the oil well, the tubing was bent into a flat coil and then led to the intercooler, where it discharged. These coils were securely fastened to the inside of the oil wells to prevent any chance of their fouling the connecting rods. Line 3 went to the mechanical lubricator, made 20 turns around it, and then led to the intercooler.

The loss in efficiency from bypassing the high-pressure cylinder was negligible as compared to the probable maintenance expense resulting from insufficient lubrication. If the air compressor had been steam driven, the same idea might have been worked out with steam coils, taking proper steps to guard against condensate leakage into the oil.

Cleveland, Ohio. L. R. Brown.

652. How to Test Cylinder Walls of Air Compressors for Tightness.

The machine was a two-stage, cross-compound unit having cylinders 25½ and 40 in. in diameter, with stroke 30 in. Valve *D* on the water-inlet line (Fig. 192) was closed so that water could not enter the jackets. The water-cooling discharge line was broken and plugged at points *K*, *L*, *M*, and *N*. At points *X* and *Y*, rubber hose was attached, the end of each piece of hose being submerged in water. A short length of hose was also attached to the discharge from the cylinder jacket at *J*, and the end of this likewise was submerged in a pail of water. The theory of the test was that after the machine was started a defective casting would be indicated by air bubbling through the water. Under these conditions, the low-pressure cylinder was tested and found perfect. The high-pressure cylinder, however, showed a decidedly bad leak. The leak was found by removing the cylinder head, keeping valve *D* closed, and making a hydrostatic test through connection *J*.

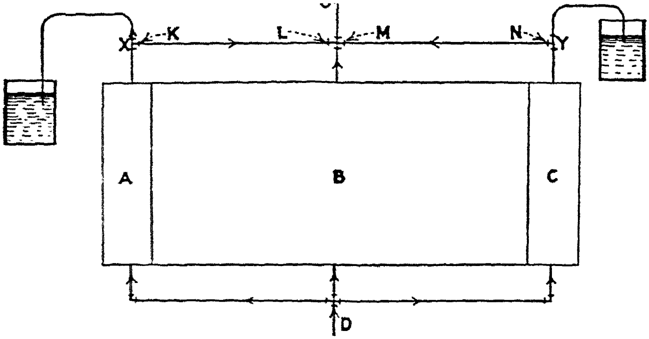


Fig. 192.—Connections for air-leakage test on compressor cylinder.

Parnassus, Pa. JOHN C. HOAR.

653. Removing Moisture from Air Lines.

The high-pressure air system was becoming filled with water. Ten feet of 6-in. pipe was purchased with flanges and blind flanges, thus making it a receiver (Fig. 193). Inside this receiver were placed two coils of 100 ft. each of ½-in. galvanized-iron pipe connected in parallel. The compressed air was admitted to the receiver through a 1-in. opening tapped with the end of a

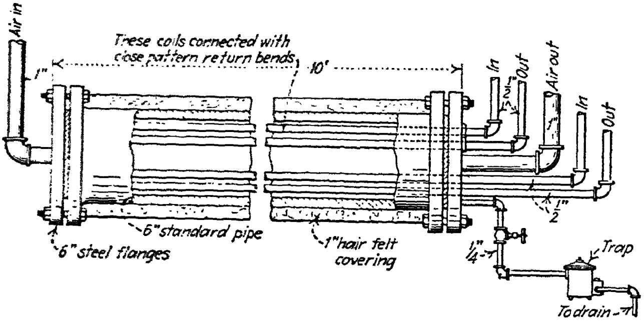


Fig. 193.—Section through moisture remover.

6-in. blind flange flowing parallel to the coil and taken out of the other blind flange, thence to the air receiver. Water from the cooling coil was tapped from the air-washer pumps connected with the air-conditioning system, average water temperature being 55°F.

Upon completion of this aftercooler, it was possible to take air into the compressor at a temperature of 77° dry bulb and 60° wet bulb, compressing it up to 70 lb. pressure, delivering it to the receivers, and then distributing it through the pipe line out into the building with no moisture present in any part of the system. Since the installation has been made, there have been no traces of water in the receivers.

Hollywood, Calif. LAURALINE MACK.

654. Unique Moisture Trap for Compressed-air Lines.

It is customary to install moisture traps in the discharge lines of air compressors. According to the standards of the Compressed

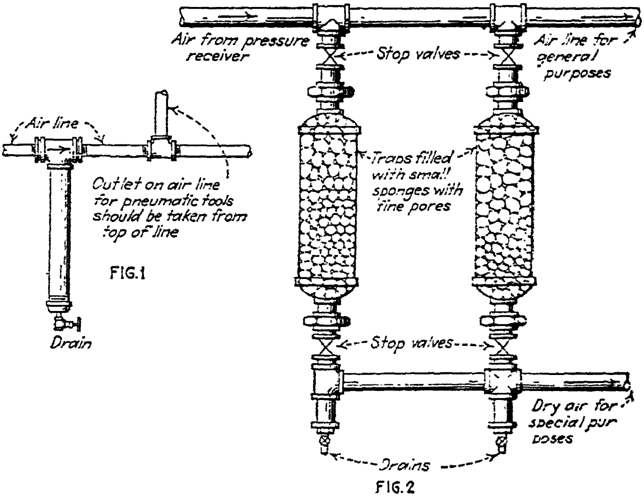

Air line
Outlet on air line for pneumatic tools should be taken from top of line
FIG.1
Drain
Air from pressure receiver
Stop valves
Air line for general purposes
Traps filled with small sponges with fine pores
Stop valves
Dry air for special purposes
Drains
FIG.2

FIG. 194.—Conventional moisture separator (Fig. 1) and sponge-filled type (Fig. 2).

Air Society, good results can be obtained with moisture traps of pipe fittings consisting of T's set in the pipe lines at frequent intervals, the T's having a pipe leg hanging down to a drain at the bottom. The T and drop leg should be made of fittings several sizes larger than the pipe line. Figure 194-1 shows the design.

There are, however, compressed-air systems where no traces of either water or oil are permitted in discharge air, particularly when used for spray guns and the like. Moisture traps of conventional design do not always suffice for such installations.

Good results are obtained in a plant where a moisture trap is used consisting of a pipeful of sponges, as shown in Fig. 194-2. Two traps are connected in parallel, so that there is always one in operation while the other one is being cleaned. The sponges are removed from the traps periodically and thoroughly washed and dried before they are put back into service.

Galt, Ont.

Ernest L. Maag.

655. Cheap Separator.

We made a number of separators from odd pieces of pipe, as shown in Fig. 195. These proved satisfactory and saved us considerable money.

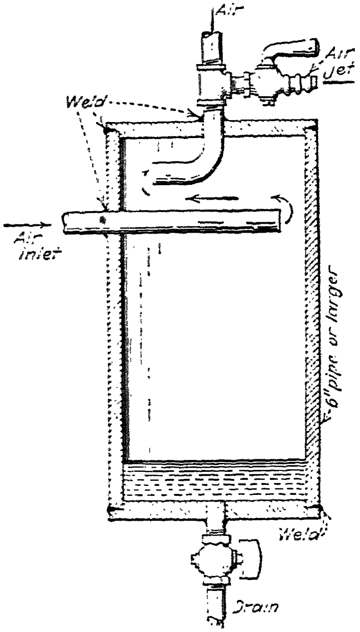


Fig. 195.—A cheap separator.

Tokyo, Japan. T. Namiky.

656. Compressed Air and Vacuum from One Machine.

Vacuum was needed for a new process. There was no vacuum pump, but a two-stage air compressor provided compressed air for gas-engine starting, so the vacuum line was connected to the intake of its low-pressure cylinder.

There came a time when low-pressure compressed air and vacuum were needed at the same time. There was a safety valve between the two stages. The engineer simply removed it, and the high-pressure cylinder furnished air, while the low-pressure cylinder maintained vacuum, thus using both cylinders single stage.

Coffeyville, Kan. EARL PAGETT.

657-663. Seven Welding Tips for Compressor Installers.

657. In the installation of small two-stage compressors, a considerable reduction in cost may be effected by welding as much as possible, even in high-pressure discharge lines.

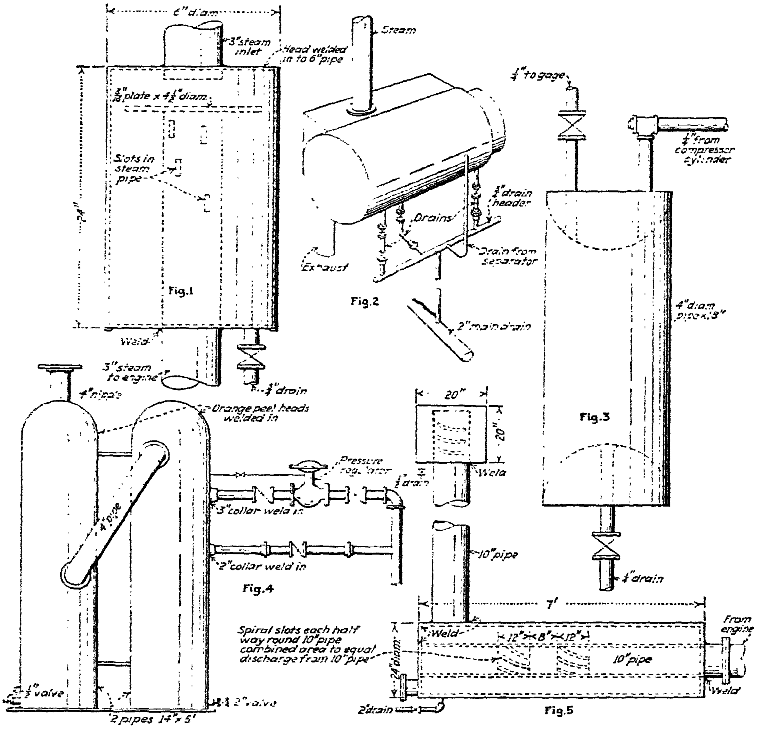


FIG. 196.—Details of construction and dimensions of parts made by welding.

The steam separator can be made in the field from a piece of 6- or 8-in. pipe 24 in. long, as in Fig. 196-1. The outlet pipe is so placed that the flat plate on the upper end will be about 3 in. from the inlet. The separator is welded into the steam line just above the throttle valve. The rest of the steam line to the boiler is also welded at the joints.

658. Unsightly steam drains open to the floor are also done away with. These drains, $\frac{1}{2}$ and $\frac{3}{8}$ in., are run into a $\frac{3}{4}$-in. header about 8 in. below the cylinder. This, in turn, is welded into a $\frac{3}{4}$-in. drop into a 2-in. main drain. There are no fittings other than nipples and unions (Fig. 196-2), all connections being welded.

659. At the gages, there is often an accumulation of water and oil in sufficient quantities to impair accuracy; also, in the case of high-pressure gages, the shock due to water in the air may be sufficient to cause damage. This is taken care of by means of a drip bottle, or absorber (Fig. 196-3), made from a piece of 4-in. pipe 18 in. long with "orange-peel" heads. Any pulsation in the pressure is absorbed in the bottle, and oil or water can be periodically drawn off.

660. When the compressor is used on gas, a scrubber is necessary. A practical type of scrubber can be made up from two 14-in. pipes 5 ft. long, as in Fig. 196-4. These are welded on a piece of $\frac{1}{4}$-in. plate, with 6-in. spacers between. The heads are of the orange-peel type, and in one a 4-in. nipple is welded. In the side of the other a 2- and a 3-in. coupling are welded. The 3-in. connection should be about 2 ft. 6 in. from the floor. The two tanks are connected by a 4-in. pipe welded on diagonally, as shown. In operation, sand and grit are deposited in the first section, and the water and oil in the second. This has been found a most efficient type scrubber. Design can be modified to suit conditions.

661. In a gas-engine-driven compressor of larger size, that is, around 100 hp., a muffler (Fig. 196-5) can be made up as follows:

The shell is rolled from plates $\frac{1}{4}$ in. thick into a cylinder 24 in. in diameter and welded up the seam. Flat heads are also welded in the ends. A 10-in. pipe is then flanged at one end and is inserted through one head and welded in place. Previous to this, spiral slots are cut in to equal the area of the pipe. A 10-in. uptake is welded in the top of the shell. This pipe is fitted with a head on the discharge, as shown.

662. In certain classes of work, it is usual to have Van Stone or similar flanges fitted to pipe sections welded in place in the field. As this type of flange is loose on the pipe, it can be turned to suit the companion flange.

663. Where a reduction in pipe size has to be effected, it can be quickly done by slotting the pipe with a torch and then bending in the pieces until the desired reduction has been obtained. This is welded to the smaller pipe and makes a neat and satisfactory reducer.

Arcadia, Calif. M. C. Cockshott.

664. Smooth-on Repairs Leak.

We had a 9- by 10½-in. leak in the water jacket of a 29- by 30-in. air-compressor cylinder. As a new cylinder would cost approximately $2,000, we decided to try a repair with Smooth-on.

The hole was in a very inaccessible place, being in the lining of the water jacket between the cylinder proper and the air-discharge passage, so the job was rather difficult. To avoid obstructing water circulation in the jacket, we cut three pieces of 1½-in. pipe 18 in. long, bent these to the proper radius, and put them in position against the wall of the cylinder. We then mixed up a 5-lb. can of No. 4 cement and spread it on these pipes. This was followed with a piece of heavy ½-in. mesh wire and another coating of cement. We repeated this until we had mixed up six 5-lb. cans of cement. This was allowed to set several days. A piece of steel plate was then bent to the proper radius and secured in place on the top of the patch by four ¾-in. studs. Additional cement was put on to cover the work ½ in. thick before putting the plate in place.

When the job was finally tested, it proved to be water- and airtight, and the compressor has operated without further trouble.

Pittsburg, Kan. W. L. Lapworth.

665. Accident to a Turbine Blower.

Two large turbine blowers supplied the air to a blast furnace, the intention being to have one set as a stand-by. Delivery pipes were connected to a common header, and a shut-off valve was placed on the delivery side of each blower. So that the spare should always be ready, they were run alternately.

It was necessary to change over from one set to the other, without interrupting the blast. The second engineer therefore begun to run the spare set up to speed before shutting down the first blower. When the spare blower was ready to take full load, he ordered his assistant to shut the steam valve of the first blower. The assistant did so, but he did not close the air-delivery valve. The result was that the blower end of the first set acted as a turbine and began to revolve the turbine in the opposite direction.

The assistant did not notice the stopping and subsequent reversal of the machine, which took place very quickly. Noticing that the blower did not slow down, and still not noticing the reversal of rotation, the man again endeavored to close the steam valve, which was already shut off. The machine raced, the governor, of course, being out of control. A final smash was averted only by failure of the oil pump. The pump was designed to run one way only, and, when the reversal of rotation occurred it no longer operated, with the result that the main bearings quickly heated up to the seizure point.

Subsequently, automatic shut-off valves were fitted to the air deliveries.

West Bromwich, England. H. MAPLETHROPE.

666. Accident to Turbine Blower.

Such danger is especially great when two or more machines operate in parallel. If the units are turbine-driven, there is always the possibility that the overspeed emergency trip of one of them will unlatch and shut off the steam. Motor-driven units may similarly lose their power through the functioning of fuses or other protective devices.

Should this happen, the pulsation, or "squealing," of the stalled machine will warn the operator that something is amiss, but he may be unable to get the air valve closed in time to prevent reversal, or he may make the natural but unfortunate mistake of trying to shut off the power.

Best practice dictates check valves with machines operated in parallel. The additional investment and increased power consumption will usually be warranted by reasons of safety.

Here is another accident of the same type: The two units were turbine driven, and the oil-operated governor valve held open by oil pressure. Each machine had two oil pumps, one driven from the main shaft, the other an auxiliary arranged to cut in at low pressure. The accident happened when both machines were slowed down for a short period. The auxiliary pump of one unit failed to cut in instantly, and the decreased pressure allowed the governor valve to close. The machine reversed, and although the auxiliary pump had by this time cut in and was running furiously, it could not build up pressure again, because the main oil pump was operating in reverse, pumping oil from the system as fast as the auxiliary pump could deliver it. Consequently, there was insufficient oil pressure either to admit steam to the turbine or to lubricate the bearings. Damage was limited to burning out of one bearing.

Madison, N. J. B. F. POWELL.

CHAPTER X

GAGES AND METERS

667. Testing Rack for Flow-meter and Instrument Clocks.

In power stations and industrial plants where steam-flow and other meters are extensively used, it is necessary to have some routine whereby the meters will receive periodic care and attention. This is essential to keep them in good working condition and also to check their accuracy.

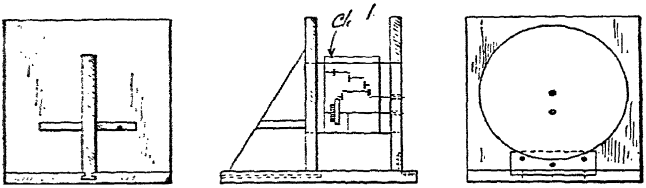


FIG. 197.—Rest for clocks being checked and adjusted.

We have found that it is a good practice to keep a clock for the recording meters as well as other spare parts and at regular intervals take out the clock in a meter and replace in with a spare. The mechanism taken out is thoroughly overhauled and cleaned. After reassembling, we set up the mechanism on a wooden rest, as shown in Fig. 197. Attach a hand and a face and check the clock for accuracy before changing again.

Port Arthur, Ont. R. G. EDWARDS.

668. Checking Power-plant Thermometers.

The best way is to put a duplicate well in the line close to the regular recorder-bulb well. This auxiliary well should be a small glass thermometer receptacle with a screw top to keep out dust, sediment, etc., and should be kept full of oil, so that the true temperature of the flowing medium will be readily obtainable without waiting for it to come to temperature.

I have made it a point, particularly on steam lines, feed-water and high-temperature lines, and pressure lines, to place one of these small wells with every recording thermometer. It saves a lot of disagreeable and hot work and makes checking thermometers a pleasure.

Pittsburgh, Pa. L. G. JONES.

669. Controlling Steam Pressure Automatically in a Small Plant.

We first purchased a hydraulic regulator and attached the plunger, by means of pulleys and weights, to a butterfly damper in the main air duct, so that when the steam came up to the desired point the forced draft would be shut off automatically. This single control had the objectionable feature that the coal kept on feeding after the air was shut off, so, by means of additional counterweights, flexible cable, and steel pulleys with turnbuckles for fine adjustment, we connected the regulator to the feed latch of the stokers (Fig. 198). This overcame the difficulty, and we obtained a complete automatic control of the fires. The hydraulic regulator was mounted on the engine-room wall for convenience of observation and adjustment.

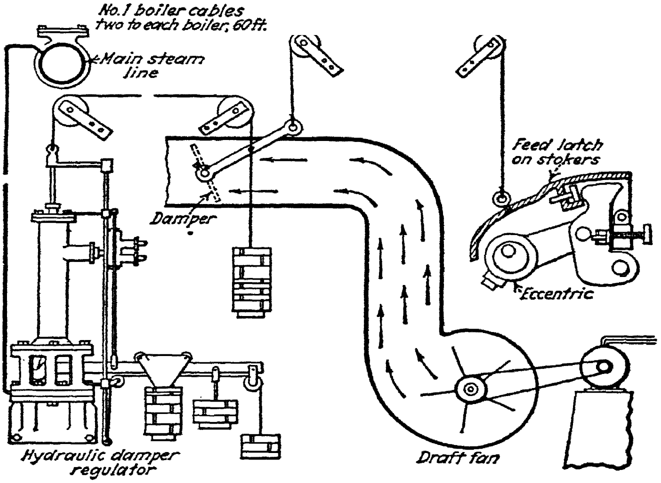

No. 1 boiler cables two to each boiler, 60 ft.
Main steam line
Feed latch on stokers
Damper
Eccentric
Hydraulic damper regulator
Draft fan

FIG. 198.—Arrangement of regulator and connections to stoker-feed latch and fan.

At 150 lb., the air and coal are shut off simultaneously, and pressure fluctuates about 3 lb. at 150 lb. pressure (1½ lb. each way). Total cost was approximately $275, but the operators consider that it was well worth while, as they are saved many miles of walking, and the labor and attention required in regulating the fires are reduced to a minimum.

Humboldt, Sask. C. A. CUTTING.

670. A Pressure Control That Is Good.

Recently, I made a switch control of a 2-in. union, to be used on a pressure line where the pumps were connected to tanks, pits, and other places where a pump is likely to become unprimed.

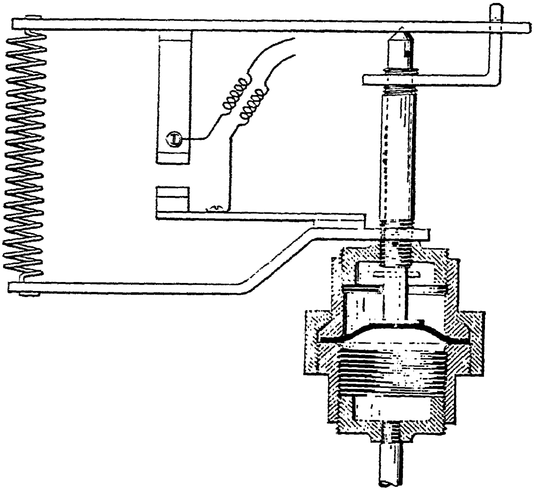


FIG. 199.—Pressure alarm as completed.

By taking a lip-joint union, such as is used in waterworks lines, and cutting the lips off, I made two plain flanges, which were held together by the nut as shown in Fig. 199. Between these flanges I placed a piece of ⅛-in. rubber gasket to cover the full opening of the union. Against this I placed a plunger which has a pin set in the stem to prevent the plunger from rising too high. The upper end of the plunger rested against a piece of strap iron, to the other end of which was fastened a spring. Movement of the plunger opens or closes the electric contact.

Wichita Falls, Tex. CURTIS GIBBS.

671. How Kerosene Is Used to Keep Fuel-oil Gage Glasses Clean.

Engineers who have had experience in using fuel oil either under boilers or with diesel engines know how difficult it is to keep the gage glasses clean on the oil tanks so that oil level can be readily observed.

We inject a little kerosene in the glass above the oil, through the pet cock on the top of the gage. The kerosene floats on the top of the oil and keeps the glass clean for a long time.

Brooklyn, N. Y. O. J. JONASSEN.

672. Use of Fiber Washer Stopped Gage-glass Troubles.

A great deal of trouble was experienced with the gasket rubbers on the gage glass's blowing out, causing the glasses to break.

A fiber washer 1⁄16 in. thick and 3⁄4 in. inside diameter and with an outside diameter to allow an easy fit into the gage-cock nut was put into each nut before the rubber gasket. The fiber washer fitted the glass fairly closely and would not allow the rubber gasket to push out between the glass and hole in the nut (Fig. 200). This plan was tried with gaskets that normally held for only an hour or two and is holding them securely.

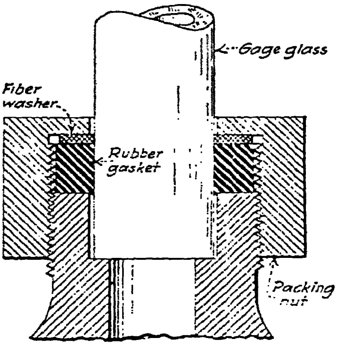


FIG. 200.—Fiber washer prevents pushing of rubber gasket.

The fiber does not scratch the glass, therefore will not cause it to crack and break, as would a metal washer or a nut with too snug a hole in it.

Denver, Colo. F. R. RAWSON.

673. Care of Mercury in Steam Flowmeters.

Where steam flowmeters have a mercury column, the mercury may be contaminated by impurities in the steam. In these cases, it is necessary to blow the connecting steam pipes out and install a suitable steam filter where the meter piping connects to the steam main. If the steam is quite clean, the mercury will not be contaminated.

Mercury can be cleaned sufficiently for use in meters by allowing it to fall in a fine spray into a solution of 25 parts nitric acid and 75 parts distilled water. The mercury should then be collected and passed in a similar way through distilled water. It may be dried by passing through a clean filter and then heating in a porcelain dish to 230°F. for a short time.

Welwyn, England. W. E. WARNER.

674. Leaks inside and Not outside the Orsat.

A portable Orsat developed what seemed to be a persistent leak in the CO, or cuprous chloride, bottle. All connections were refitted with new rubber gaskets and thoroughly shellacked. But this failed. In an attempt to find the hole, the liquid in the bottle was put under pressure. The leak was really a formation of gas inside the bottle and not a leak at all. Connections that caused the trouble were arranged as shown in Fig. 201-1. The granulated copper tube lining the steel packing nut had deteriorated, so the cuprous chloride solution could come in contact with the steel and form gas.

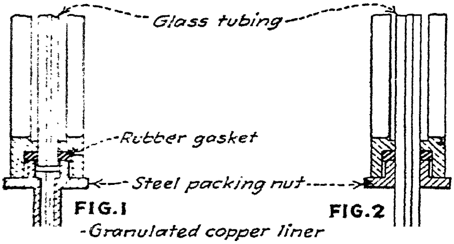


FIG. 201.—Detail of repair to Orsat.

To remedy the fault, the glass tube was replaced by a longer tube extending through the packing nut to the bottle, as in Fig. 201-2. The tube part of the packing nut was cut off, and a hole drilled in the body large enough for the tubing. The rebuilt connections were entirely satisfactory and have the advantage of eliminating two possible sources of leakage.

Bozeman, Mont. GERARD PESMAN.

675. Proper Piping Arrangement Insures Easy Cleaning of CO_2 Lines.

When installing CO_2 indicating or recording instruments, provisions should be made to keep the piping and fittings clean.

In some plants with the piping system laid out as shown in Fig. 202, in the event of a connection plugging up, and also once a week, the following procedure is practiced:

Valves *B*, *D*, and *E* are closed, and valves *A*, *C*, and *F* are opened. After steam or air, whichever is used, blows through valve *F*, showing that the drop leg is clear, this valve is closed. Pressure is maintained on the line for a minute or so longer to clean the sampling tube. Indication that this tube and the rest of the piping are clear may be had by closing valve *C* for a moment, then opening it and at the same time observing pressure gage *G*. If the line is clear, as soon as valve *C* is reopened a noticeable reduction in pressure will show as flow is established. If the line is still stopped, the pressure shown by the gage will remain almost constant.

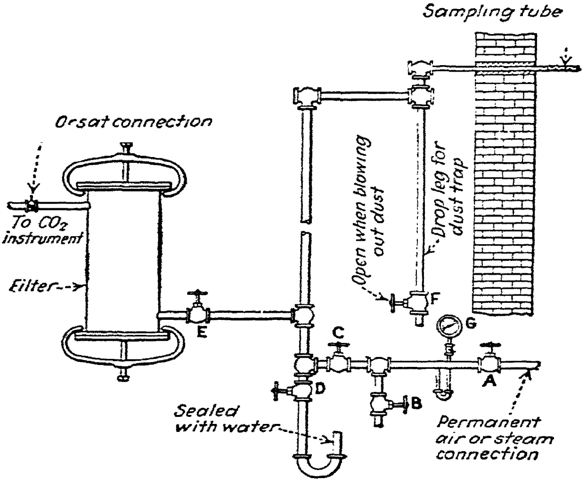


FIG. 202.—Piping arrangement for cleaning CO_2 lines.

If the pressure application does not clear the line, removal of the plugs in the various T's and crosses and the use of a long piece of hooked piano wire will readily clear the obstruction.

Valve *B* is left open during normal operation. In case of a leak through *A*, an indication of this is given by the escape of air or steam. This valve being open also prevents any possible air or steam leaks through valve *C* into the instrument.

Cleveland, Ohio. C. A. ARMSTRONG.

676. Recording V-notch Meter Made from Discarded Material.

It was desired to know the amount of water wasted through a discharge line in order to determine whether or not it would be profitable to divert this water to the feed-water heater. The line was rather inaccessible, but to obtain a record of the amount of water flowing, a recording meter was improvised. Having available in the plant parts of several old recording meters, one of them was used as in Fig. 203.

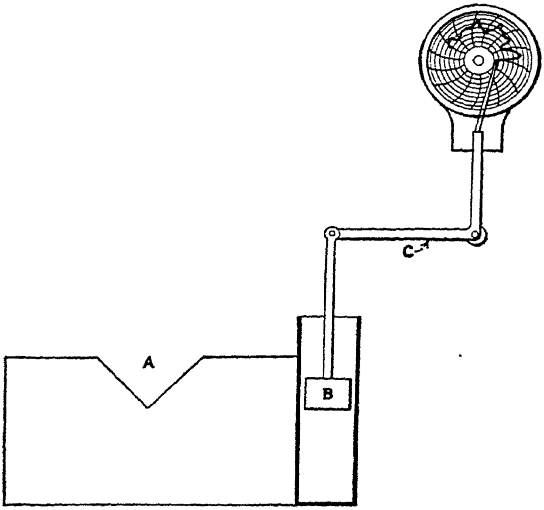


FIG. 203.—V-notch meter of discarded material.

A is a V-notch weir constructed from old box boards and a piece of sheet metal, the seams being caulked with waterproof cement to prevent leakage. A float *B* was placed in a stilling box on the side of the weir and connected to one end of a bell crank by a hinge joint to allow free vertical movement of the float. Guides were arranged about the rod to prevent the float from jamming against the side of the weir.

The bell crank *C* was arranged to pivot about a fixed point below the meter casing, and to its upper end was fastened a pen arm such as is used in recording instruments. The pen rested on a circular chart which was turned by a clock mechanism. The bell crank was so proportioned that when the water level raised the float to the top of the V notch, maximum deflection on the chart was obtained, the zero reading being at the point where the water was just level with the apex of the V. The chart was calibrated in inches by means of a hook gage. This apparatus worked very satisfactorily, and from the readings obtained the amount of water flowing through the line was determined for different periods of the day.

Bellerose, N. Y. HENRY C. OATLEY.

677. Compressed Air Used to Clean CO_2 Recorder Filters.

Connections for CO_2 recorders, being in the path of the flue gases, are affected by any impurities and dirt in them. In order to prevent dirt and other material's being carried into the instrument, a filter is usually placed between it and the gas inlet. The best way to clean the filters is by compressed air. A valve should be placed so that the instrument can be disconnected from the filter, and a connection made for the compressed air to pass through the filter in the reverse direction to the gas flow. At first, the air pressure should not exceed 10 lb. per square inch but should be increased to between 15 and 20 lb. as cleaning progresses.

The filter should offer but little resistance to the air flow. If air gages are connected in the pipe on either side of the filter, these will, if the filter is clean, register approximately equal. If the filter is dirty, the two readings will differ considerably. Pipe connections must be kept clean. This is very important in the pipe between the filter and the intake from the flue.

Hertfordshire, England. W. E. WARNER.

678. Pressure-gage Maintenance.

In one plant, a maintenance expense amounting to considerable in a year was the item of pressure gages. This expense was due to the destruction of movable parts in the gages, especially the expensive high-pressure instruments.

Vibration, or rapid, continuous changing of tube, sector, and pinion positions, was the usual cause of short life. It was necessary to ascertain whether the vibration was being transmitted through the metal walls of the gage line from the machine to which it was connected or if it was being transmitted through building construction to the gage mounting. In the former case, a firm clamp was constructed to support the gage line just below the gage, and the line bent into a six- or eight-turn spiral just below the clamp. A 1- to 6-in. spiral was used, depending on the size and material of the pipe.

If it was found that vibration was being transmitted from high-speed machinery through the building construction to the gage mounting, the gage was protected by mounting it on a cork base several inches thick, and in turn the base was bolted to the panel.

If rapid pressure fluctuations were causing excessive wear in the gage, these were dampened sufficiently to eliminate unsteady action by a "dampener," or "snubber."

Milford, N. J. H. M. SPRING.

679. How Vacuum Gage Is Protected against Damage by Pressure.

Figure 204 shows how I protected a vacuum recording gage after it had been wrecked by exhaust pressure because a float stuck open in a deaërating heater. The end of the pipe leading to the gage is plugged, and a 1/16-in. hole is drilled in the plug.

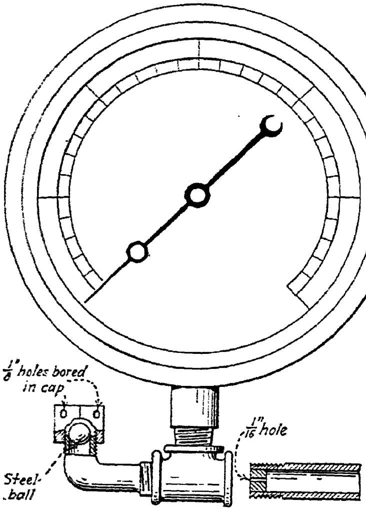


FIG. 204.—Vacuum-gage connection with pressure relief.

This decreases the effect of any pressure surge in the pipe. To provide a relief for any pressure that may get into the pipe, and at the same time make the line airtight under a vacuum, an elbow having a ball check on the outer end is attached at the other end of the T. The ball is inclosed by a cap with relief holes drilled in the side, as shown.

Jeannette, Pa. EDWARD B. BACK.

680. Mercury-type Tank-level Gage.

Figure 205 shows a tank-level gage that has been in operation at this plant for about a year and has proved reliable. To change the range of the gage it is necessary only to add mercury or change contact adjustment. The contacts are held in position by tightening down on the rubber bushing. The box is steel, and the contacts welding-rod steel. Terminals are made of commutator brush pigtails soldered into a hole drilled in the

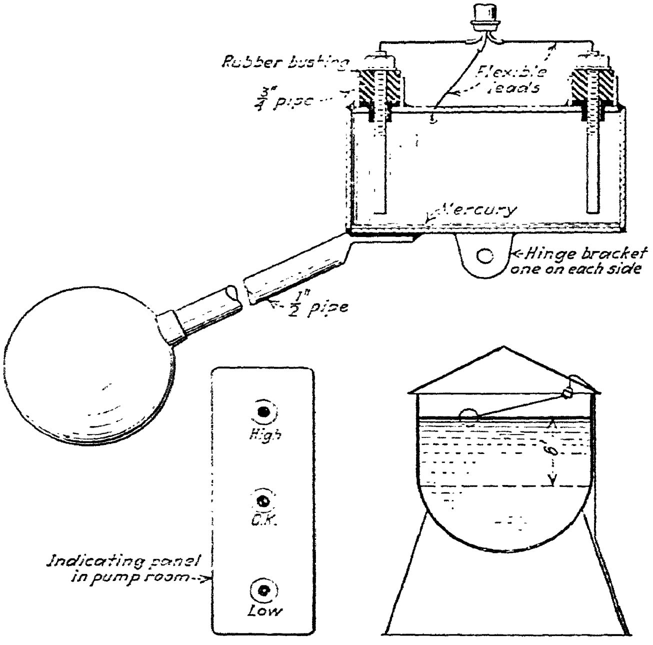


FIG. 205.—Mercury completes the circuit between box and terminals.

contacts. The ground terminal is connected to the building ground, and the other terminals are connected to signal lights in the pump room. We have an O.K. light to show when the system is in service, as we should not otherwise know when the power was off the line.

Ashville, Ohio. P. J. Bozman.

681. Practical Method of Tightening Gage-ring Glasses.

Where time can be taken, and facilities are at hand, gage-ring glasses are usually set in the ring with a mixture of plaster of paris or other easily cleaned, and not too hard, filling. Often, however, it is necessary to set a glass with nothing of that nature available. And if the glass has been poorly cut, as is often the case, it should be set in with some kind of retaining material.

Tin foil, rolled into a long, stiff, and somewhat flattened strip, is pushed into place with the glass and further packed with the point of a small screwdriver. A ready source of such foil is old Ford ignition coils.

Missouri Valley, Iowa. F. W. Bentley.

682. Losses in Draft-gage Pipe Lines.

Experiments were made on 500 ft. of ¼-in. bore copper tubing in 50-ft. lengths, coupled with short pieces of rubber tubing. Two calibrated inclined draft gages of 1-in. range, 10-in. scale, with a tube inclination of approximately 1 in 10 in., were used in parallel. One gage was connected with the source of pressure by the 500 ft. of copper tubing referred to, and the other was connected with a short piece of rubber tubing.

Under repeated experiments of 1-in. pressure quickly applied to the two gages simultaneously, with a liquid travel of 10 in. in the two gages, the time lag in the 500-ft. line was 10 sec. when the two gages checked precisely. In releasing the 1-in. pressure, the lag in the pipe line was 20 sec. when the liquid in both gages stood at zero. A sudden change in pressures of ½-in., minus or plus, between the ¼- and ½-in. readings on the scale, gave a lag in the long line of from 5 to 10 sec. when the gages checked exactly.

Chicago, Ill. Lewis M. Ellison,
Ellison Draft Gage Co.

683. Steam-gage Connection to Prevent Clogging.

Figure 206 shows an unusual way of connecting a steam gage. It has some points of advantage over the usual method, particularly where water conditions are bad and where the pipe tends to seal or clog up. It is almost impossible for sediment or scale to be blown into the horizontal or vertical pipe connecting the steam gage when the cock is opened, as it is a straight blow through. The piece of pipe, or drop leg, between the T and the cock serves as a trap for sediment and scale.

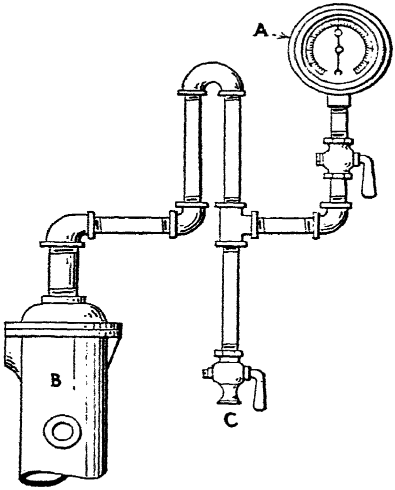


Fig. 206.—Gage connection to avoid clogging.

Uffington, Ont. James E. Noble.

CHAPTER XI

MECHANICAL TRANSMISSION

684. Practical Method of Renewing Cable Sheaves.

I operate two machines with a large number of cable sheaves or blocks. The sheaves are cast steel, with a cored-out annular space around the pinhole where oil is put to lubricate the pin.

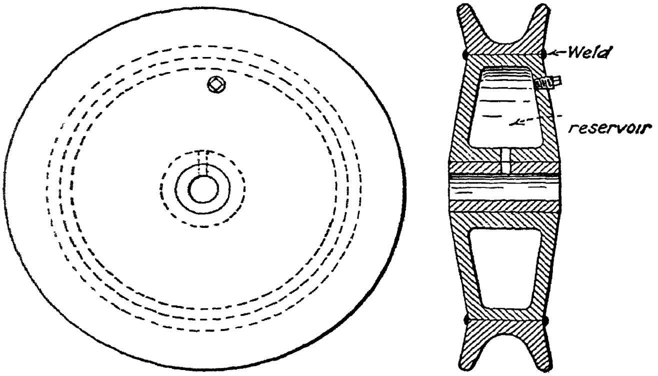


FIG. 207.—New rim shrunk and welded on old center.

To replace one sheave costs about $50. We have found that when one of the sheaves wears until the rope nearly penetrates the oil pocket it can be renewed for $15 in the following manner:

Turn down the wheel on a lathe until a surface is obtained upon which a new steel ring may be shrunk, the ring being later turned to the required diameter and shape. Extra reinforcement and security may be had by welding a bead around the joint as shown in Fig. 207.

Butler, Tenn. W. S. WHITING, JR.

685. Wooden Roller Used as a Cable Guard.

Trouble frequently occurred with the cables coming off the sheaves of a hoist when the engine was starting.

The cables were protected against coming off by planks bolted close above them, but the cables would wear deep grooves in the planks and would come off anyhow.

To overcome this trouble, we made a wooden roller for each sheave and bolted its bearings where the planks were supported, allowing it to roll against the sheave rim.

Ironton, Minn. A. LEKSTROM.

686. A Practical Flywheel Guard.

Figure 208 shows a flywheel guard that can be swung back and so give access to the wheel for barring. It consists of two light angle-iron frames hung from center bars of ordinary iron pipe, the latter being provided with pivoted and shouldered ends to hinge in metal sockets in the floor.

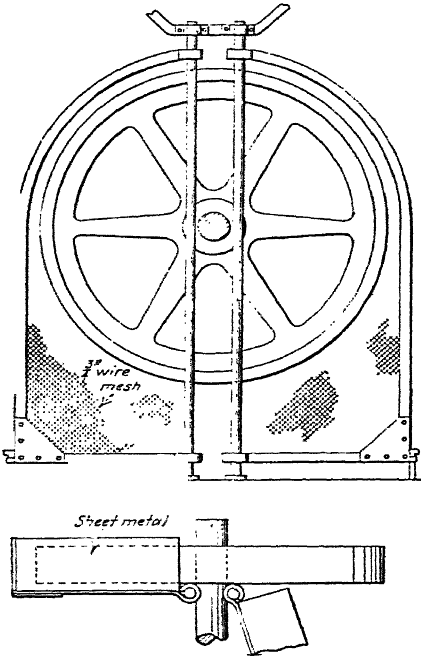


FIG. 208.—Guard made to swing free of flywheel.

The sides of the frame are inclosed with light sheet iron, the front of the guard being covered with $\frac{3}{4}$-in. mesh wire netting. Tops of hinge tubes can be supported either from the roof or by means of stays from a convenient wall. Bolts, fixed on each half of the guard, drop into holes in the floor and keep the guard in position.

Liverpool, England. W. MASON.

687. Split Pulley Tightened to Shaft.

I had to make a grooved pulley, 10 in. in diameter, and place it on a shaft already crowded with pulleys. A split pulley was necessary, but how to tighten a thin wooden pulley of this diameter in a neat, effective manner was a problem.

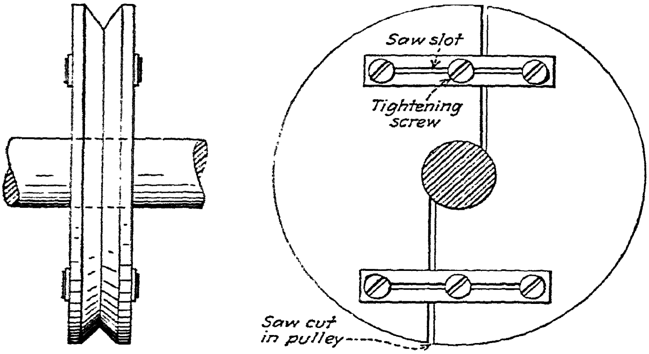


FIG. 209.—Split pulley and tightening method.

I made four sheet-steel straps, drilled them together, three holes in each, all countersunk. Next, a saw cut was made from the center hole to each outside one. The pulley was split as shown in Fig. 209 so that two screw holes could be placed on one side and one on the other. The center screw holes in the pulley were countersunk to facilitate tightening it on the shaft. With the pulley held tightly on the shaft, the four straps were fastened in place with a screw in each end.

Tightening the center screws spreads the straps apart in the middle and pulls the two halves of the pulley more tightly on the shaft.

Hamilton, Ont. H. MOORE.

688. Adjustable Bushing in Loose Pulley.

When a rattling loose pulley was removed, we found that the shaft was also badly worn. The shaft could not be removed without difficulty and expense. The condition of the shaft at first raised the question of the possibility of bushing the pulley without renewing the shaft, but the problem was solved by making an adjustable bushing of steel with a ½-in. wall and tapping for six headless setscrews in equidistant pairs. I bored the pulley to fit this bushing with a running fit and cut an oil groove in it.

The adjustable bush was first put into place, and the setscrews tightened. The bushing was then removed, and flat spots filed on the shaft where the screws made contact. The bushing was put back into position, and the six screws adjusted to make the bushing run true. Then I peened in the top of each hole so that there would be no chance of screws' working loose and scoring the pulley. The pulley is working as well as when new.

Hamilton, Ont. H. MOORE.

689. Welded Rings Save Large Pulley.

A 96 by 20-in. cast-iron pulley cracked through the hub over the keyseat. Welding was tried, but it opened up after a few days. Two wrought-iron rings were then rolled and scarf welded by the blacksmith. Each ring was made from 3- by ¾-in. bar and of a diameter to fit tightly over the hub. Two ⅞-in. setscrews were put into each ring.

The rings were forced on the hub so that the setscrews were at right angles to the key seat. When the rings were in place, the setscrews were tightened to close the crack under heavy pressure. A key with about 0.1-in. taper per foot had been used, and this taper evidently was the cause of the trouble. The repaired pulley has shown no signs of distress.

York, Pa. J. S. CARPENTER.

690. Temporary Repair for a Small Pulley.

The shaft collar on an air compressor became loose and allowed the idler pulley to fall on the concrete floor, breaking the spokes off near the rim.

Holes were drilled through the rim quite deep into each spoke. They were reamed through the rim to just beyond the break in the spoke and countersunk in the rim. The hole in each spoke was then tapped to the bottom, a piece of cold-rolled steel threaded, screwed firmly into each hole, cut off the proper length, and riveted down until the cracks in the spokes were drawn tightly together.

Coffeyville, Kan. P. A. GEFF.

691. Emergency Bushing for Split Pulley.

An emergency called for a 24-in. pulley to run a machine temporarily at a different speed from the one used. A pressed-steel pulley of the proper diameter was on hand, but the bushing was too small for the shaft. The hole in the hub of the pulley was 4 in., and the shaft on the machine which the pulley was to fit was 3½ in. Eight strips of hard maple were quickly cut in the wood shop ¼ by ¾ by 6 in. long. These were equally distributed around the shaft in the pulley hub, and the bolts were tightened up. The pulley ran true and carried a load for several hours.

Syracuse, N. Y. H. L. WHEELER.

692. Pointers on Balancing Pulleys.

Before any pulley is installed it should be checked to determine if it has been properly balanced. This is one practical point that engineers in general have overlooked, but it deserves careful attention. An unbalanced pulley is hard on belts. If every pulley in the plant were unbalanced there would be a variation in speed with every revolution of the pulley.

A number of engineers do not know just how to go about balancing a pulley. One of the easiest ways is to place the pulley on an arbor centered in a lathe. Give the pulley a spin and mark the side that turns down. Now place putty on the opposite side—or on two spots 120 deg. apart—until the pulley balances or will stop in any position. Then weigh the putty, cut pieces of steel of equal weight, and rivet them to the inside of the rim.

Balancing ways are better than the lathe, particularly for large pulleys. These are made by fastening narrow rigid strips of metal on the top of two sawhorses, placing them so that the arbor will rest on each, and leveling strips with a spirit level.

This method produces little or no friction, and a well-balanced pulley can be attained.

Los Angeles, Calif. W. D. CAMPBELL.

693. Pointers on Pulley Covering.

Simply cementing a leather or canvas covering to a pulley makes a better belt-adhering surface, but there are several other ways to make a much more satisfactory job.

The surface of both the wheel and the belt must be clean. Do this with an emery wheel. By holding the belt on the emery the inner surface can be well roughened, and the ends beveled to a thin edge.

If the pulley is to be crowned, the edges of the whole covering should be beveled. The roughened surface gives the cement a better hold on the leather. Edges will remain cemented longer if they are made thinner than the stock of the covering. Large wheels, where rivets may be placed through the rim, are more easily kept covered than small ones, where the pulley is of solid construction without web or spokes; so the latter must depend on cement. Where an extra high crown is desired, a strip of rubber about one-third the width of the pulley face should be cemented around the center, then another narrower strip cemented on top of this.

A small rope, or sash cord, offers a good way to press the covering to the pulley and hold it until the cement is well set. With the cover well stretched before attaching, by applying the glue quickly and attaching the whole cover, it can be put on with a more even tension than by attempting to stretch it as it is applied. When the covering has been glued and set in place on the pulley, the small rope is wound tightly to bring every portion of the covering in close contact with the pulley surface and hold it there until the glue has set.

North Bend, Neb. G. G. MCVICKER.

694. Attaching Leather Lagging to a Small Pulley.

It is sometimes necessary to use an unusually small pulley on motors. Where they are steel or cast iron there is considerable belt slippage to the small arc of contact with the belt. It is possible to overcome this by covering with leather.

The method shown in Fig. 210 is one of the best that I have used for small pulleys. After cutting the leather to proper length, ends are beveled to form a lap joint. The lagging is then wrapped tightly around the pulley and tied with wire or stout cord. Then two rows of holes, three or four holes in each row, are drilled in the pulley about ½ in. from the edge of the lap. The holes are tapped, and flathead machine screws are inserted. These are drawn down, then filed smooth.

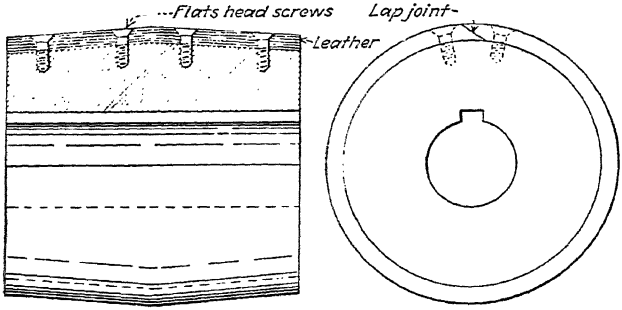


FIG. 210.—Lagging fastened to pulley by two rows of flathead machine screws.

Syracuse, N. Y. H. L. WHEELER.

695. Alternate Methods.

Here are several methods of increasing the power-carrying capacity of small pulleys in addition to lagging:

In high-speed woodworking machinery, usual practice is to cut a right- and left-hand spiral groove on the face of the pulley to release the air between the pulley and belt.

Another method is to cut a left-hand helix from the center of the pulley to the edge on one side and a groove with a right-hand pitch on the other half of the pulley face. Both methods are used for the same purpose, that is, to release the air.

Another method is drilling small holes in the pulley rim. Where the pulley is solid, it is advisable to drill a series of ⅛-in. pipe tap holes over the surface of the pulley. Holes may be reamed taper (pipe tap reamer) or tapped and plugged with small corks, a little shellac being used to cement the plugs in place. The corks may pass through a thin pulley rim or bottom in a hole. Where balance is important the holes should be carefully spaced and of equal depth. The corks should be cut off so that they project about 1/32 to 1/16 in. above the surface.

Cleveland Heights, Ohio. JAMES MCINTOSH.

696. Double-belt Drive from One Pulley.

I had to use a small belt-driven pump in a temporary position that offered no means for driving. There was a solidly built pulley on a machine just where I needed it, so I took off the pulley and cut a V groove in the center of it deep enough to take the round belt of the pump. I then mounted the pump with the pulley between the machine driving belt and slipped the round belt in place (Fig. 211).

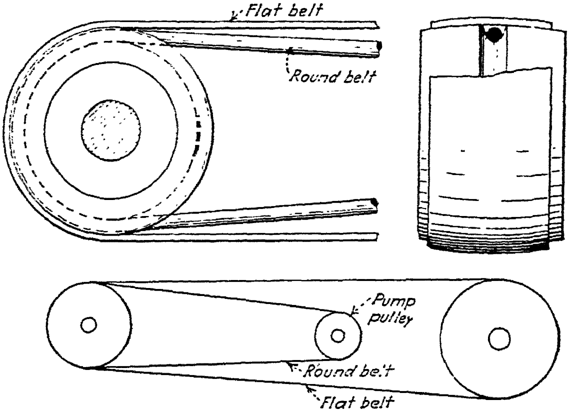


FIG. 211.—Round- and flat-belt drive from same pulley.

It worked ideally for the short time required, but I should hesitate to recommend it as a permanent drive, because of the danger incurred if the small belt should break after continued use.

Hamilton, Ohio. H. MOORE.

697. Double-belt Drive.

A double-belt drive was used in a plant where I was employed. It had become necessary to install an oil-burning system, to replace natural-gas-burning equipment.

As the oil had to be burned at different places over quite a wide area, compressed air was used for atomization, and a large positive-pressure blower was installed to supply the air. This blower was supposed to be operated at a pressure of about 2 lb. above atmosphere, and it had a pulley for an 8-in. belt.

The 8-in. belt furnished plenty of power for 2 lb. pressure, but the firemen complained that 2 lb. pressure was not sufficient. The pressure was raised to 3 lb., and the belt would not pull the load.

There was not room for a wider pulley, so an extra 8-in. belt was put over the original. This blower operated in this manner for several months on 24-hr.-a-day service.

Both belts were wire laced. I do not remember that either belt ever broke or pulled entirely apart while running. The outfit was shut down and inspected regularly, and the lacing replaced if it showed undue wear.

Coffeyville, Kan. EARL PAGETT.

698. Further Pointers.

Thirty years ago, this was a common drive in isolated electric-light plants.

At one place, I saw three generators belted to one flywheel. All belts were double endless leather, the first to the wheel being 12-in.; the other two, 10-in. It was claimed that the second, or outer, belt suffered less wear than the one next the wheel, but the difference was small, as creep between the two belts was slight. Anyone who has run two single belts together must have noted that one travels past the other and, if rivets are applied, will usually tear at the rivet holes yet, if left free, will function as a double belt.

In Mr. Moore's case, if his inner belt is endless, he need have no fear of breakage, if the belt is properly proportioned to the load, for a well-designed belt will frequently give 20,000 hr. of service and usually shows signs of wearing before the break occurs. We have fabric belts in our plant giving services at speeds which we have never been able to get a leather belt to stand, and I know of a 48-in. eight-ply rubber belt in a mill which gave ten years of service before I saw it.

Cleveland, Ohio. L. R. BAKER.

699. Abrasive Dust Wears Pulley Crowns.

Where there is much abrasive dust in the air, wearing off of pulley crowns may occur. Two expedients may be applied to minimize the damage, besides screening belt and pulley from the dust.

Where horizontally running belts are used, it is considered best practice to operate them with slack side on top, because this arrangement increases arc of contact on the pulleys. When running in abrasive dust, if the slack side of the belt is on the bottom, there will be a flapping of the belt that will help to keep the abrasive off its surface.

Directing a strong current of air on the belt where it is about to come into contact with the under side of the pulley will also help to keep it clean. A type of belting is available that has ts inner surface grooved to produce a blowing action as it makes contact with the pulley. This will also be effective.

Peoria, Ill. JOHN E. HYLER.

700. Novel Clutch.

I saw a novel clutch in operation in the Scottish Cooperative Society's Flour Mills, near Glasgow, some years ago. Fixed and sliding elements consisted of flanges with numerous wires of equal lengths embedded in their faces somewhat as shown in Fig. 212. This clutch worked satisfactorily, giving the gradually accelerated starting torque required by the mill equipment.

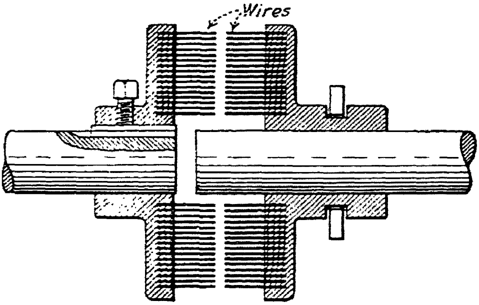


FIG. 212.—Clutch with wires as flexing element.

Saginaw, Mich. J. R. FORTUNE,
Manager, Heating Division, Wickes Boiler Co.

701. Inexpensive Flexible Coupling.

A plain flange coupling can be readily converted to a flexible one by inserting a disk of leather or fiber between flanges. For the heavier drives, fiber is recommended. A pair of drive pins assembled on the center line near the outer edge of each flange serve to retain the disk in place. Four corresponding holes are drilled in the disk on the quarter lines. The drive pins are made with shoulders and should be a drive fit in the flanges of the coupling. Holes in the disk should be about 1/32 in. larger than the outside diameter of the pins to prevent binding. Also, there should be a slight end play between the disk and the two flanges. A coupling of this design will operate satisfactorily on small drives and compensate for any misalignment of shafts.

Syracuse, N. Y. W. L. WHEELER.

702. Installing a Coupling by the Cold-shrink-fit Method.

An ingenious mechanical friend had occasion to shrink a coupling half on the shaft of a motor in a tight place close to a lot of delicate electrical equipment.

He hit upon the idea that a shrink fit can be made by cooling the shaft just as well as by heating the coupling. A near-by university physics laboratory supplied a large flask of liquid air. He placed this under a box surrounding the end of the shaft, pulled out the stopper, and waited until the air had evaporated. When he removed the wooden box, he found that the coupling half would go on easily.

New York, N. Y. JAMES A. HARRIS.

703-705. Three Safety Guards for Exposed Keys.

703. We use three types of covers for rotating keys. Where the cover could be placed over the end of the shaft, it was recessed slightly to center on the shaft and was held in place by two cap screws, one on each side of the center in the end of the shaft.

704. The second type was used where the shaft extended on both sides of a coupling or pulley. The covers were slipped over the shafting before the pulley and couplings were put on.

705. In cases where the drives were not touched, a similar cover made in halves was used; it was clamped to the shaft by two cap screws inserted in recesses so that the heads came below the surface of the guard. A close-fitting lock washer was used below the heads of the cap screws.

Newark, N. J. C. A. LEONARD.

706. Improved Felt Retainer for Roller Bearings.

Figure 213 (right) shows the common way of holding a felt ring at the end of a bearing, a felt ring being simply inserted in a groove in the bearing end.

The retainer shown at left is a more practical way of holding the ring. It is made in two pieces consisting of a steel plate nearest the housing and a cast-iron plate bolted directly up against it. One of the important advantages is that the felt is readily replaced without dismantling the bearing. The only thing necessary, when renewing the felt ring, is to loosen the bolts and push the cast-iron plates to one side, remove the old felt ring, and insert a new one.

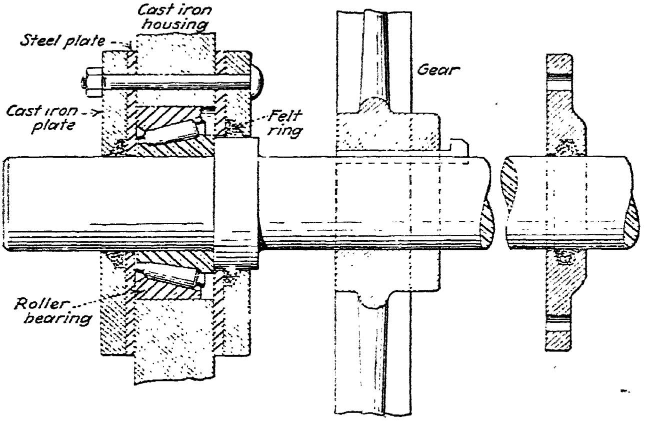


Fig. 213.—Types of felt-ring retainers.

Auburn, Mass. B. W. Bronner.

707. Use of Sulphur in Finishing Sleeve Bearings.

A simple and practical method of finishing bearings is that of using a quantity of powdered sulphur in the oil reservoir or sump of a newly finished bearing to give it a good surface. We have had a number of close-fitting brass and bronze sleeve bearings on motors that were brought to as near a perfect fit and finish as could be desired by merely running the motor idle and having a quantity of powdered sulphur in the oil. Of course, after such treatment is finished, the oil reservoirs must be thoroughly flushed out with kerosene.

If, for any cause such as insufficient or inferior oil, a sleeve bearing fails in service, and the attendant shuts the machine down before the bearing has dropped the babbitt, very often it can be saved by using the same sulphur trick. Scored parts of the bearing, which were the first spots to become overheated and seize, will be polished up by the slightly abrasive action of the powdered sulphur in the oil.

Denver, Colo. CARL A. WAGNER.

708-709. Two Changes End Troubles with Fan Bearing.

The inside bearing on a hot-air fan burned out several times, and it was thought possible that sand entering the bearing from the hot-air duct was one cause.

708. A pipe from the outside, with an elbow on the inner end, up fairly close to the bearing on the suction side, supplied cold air, but it was thought that if a hood was built over the end of the bearing and connected to this pipe, it would not only keep the sand away but also would supply cooler air to the bearing.

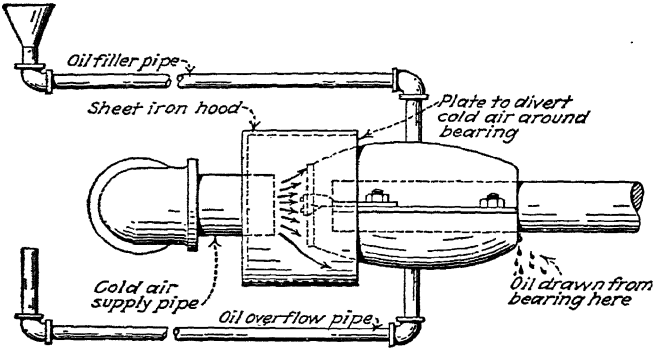


FIG. 214.—Bearing cooled and protected from dirt.

Threads were found to be good in the elbow on the cold-air supply pipe, so a nipple was screwed into the elbow, and a hood constructed from about 16-gage iron to fit over this nipple as shown in Fig. 214.

709. This seemed to keep the sand away from the bearing and keep it cool, but the suction of the fan was strong enough to draw the oil out of the bearing on the end next to the fan. A plate was fitted over the end of the bearing and fastened to one of the bearing-cap bolts to divert air around the outside of the bearing. This cured the difficulty, but it was necessary to carry a slightly lower oil level than formerly.

Coffeyville, Kan. EARL PAGETT.

710-711. Two Pointers on Machining Bearings.

Friction in bearings practically always develops near the ends because the journal and bearing are rarely in true alignment. Misalignment results in friction and excessive heating at the points of contact and finally in failure and melting out of the babbitt.

710. Instead of increasing the clearance between the shaft and bearing over the whole length of the bearing, it has been found much better to machine a clearance at the ends 0.001 to 0.002 in. greater than in the center of the bearing. This has given excellent results.

711. A simpler method consists in taking off 0.001 to 0.002 in. for a distance of 1 to 2 in. from each end.

Chicago, Ill. JAMES SILBERSTEIN.

712. Tubular Shafting Avoids Deflection in Long, Unsupported Sections.

When it becomes necessary to transmit power by shafting over a space where supporting bearings cannot be spaced closely enough to avoid excessive deflection, a tube may be used. A case in point is where it is desirable to transmit power across a wide alley between plant buildings. It is possible to provide a trussed shaft in places of this kind, but often a suitable tube shaft is all that is required. A tube will deliver far greater torque in proportion to its weight than will a solid shaft and is always well worth considering before going to the expense of a trussed-shaft installation.

Peoria, Ill. JOHN E. HYLER.

713. Making Snap-on Oil-shedding Rings Hug the Shafts.

While installing shafting where many of the rings had to be installed after the shafts were laid in and the bearings closed up, we encountered the problem of making the rings hug the shafts.

Hammering did no good and only made the rings open up still more, and pliers would not serve because those having noses thin enough to grasp the rings were not strong enough to bend them with the required twisting motion, and those strong enough to bend the rings were too thick nosed. After considerable experimenting, the little tools shown were made. It will be seen, by referring to Fig. 215, that by holding the ring back with the holding tool *B* and pushing forward on the bending tool *A*, the ring will be made to assume a smaller circular form. The rings usually have enough temper to make them spring tightly against the shaft when the tools are removed.

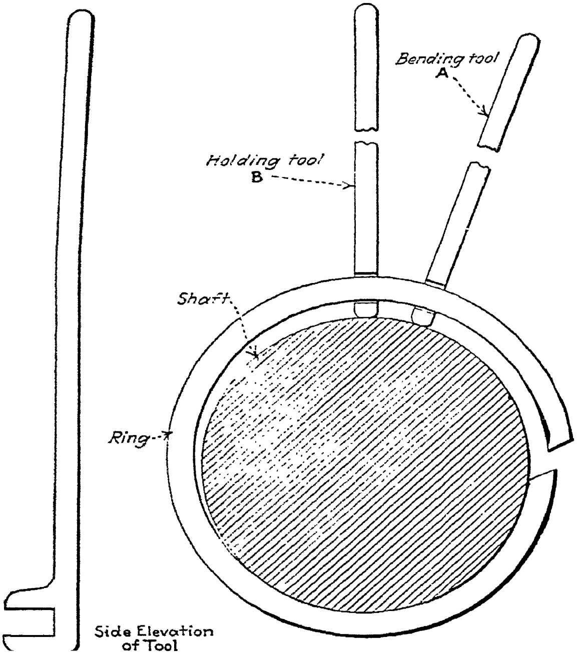


FIG. 215.—Tools used to close in oil-shedding rings.

Newberry, S. C. H. H. ILER.

714. A Simple Universal Joint.

On many occasions, I have found it necessary to open and close valves or engage a clutch by remote control. The universal joint in the diagrams will transmit the movement. To make the joint, thread four studs into a metal square (Fig. 216, top). Split down two pipe nipples with the hack saw, heat their ends, and forge out to shape (below). Drill and close down the pipe ends to fit over the studs in the block. The joint can then be connected by sleeve or union into the operating mechanism. A series of these universal joints may be used to turn bends and corners.

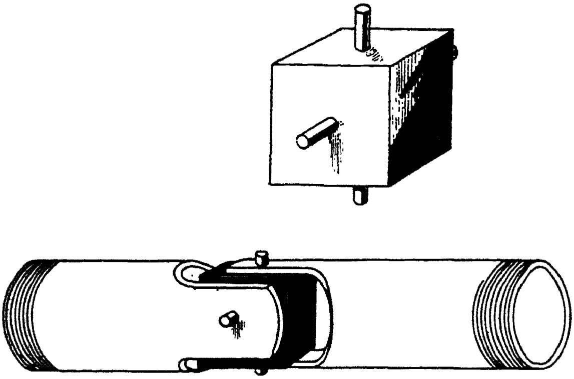


FIG. 216.—Simple universal joint.

Vancouver, B. C. S. H. COOKE.

715. Relocating Welded Gear Teeth.

I have had the job of filing out new teeth on a stripped gear that has been welded. I select a round file and a short length of rod that will lie nicely in the teeth. Then I use two clamps; one I tighten on the file, and the other I use to tighten the rod on the first clamp at a distance that enables both file and rod to lie in the teeth—three or four teeth apart. I can then locate the first tooth in the correct position by keeping the rod between the teeth as I file.

By moving the rod one tooth at a time, all the rest of the new teeth can be located with the file. Once this location is filed deep enough to act as a guide, I use the file with the rod out of the teeth.

Hamilton, Ont. H. MOORE.

716. Heavy Spur-gear Housing Reinforced.

Figure 217 shows a method of reinforcing a cast-iron housing of a 150-hp. reduction-gear transmission. The reinforcement was introduced after fracture of the housing casting between shafts of heavy gears and proved so successful that all heavy-gear housings were treated likewise.

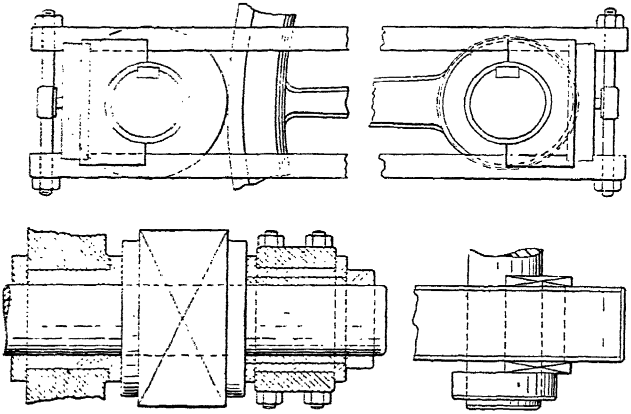


FIG. 217.—Gear housing reinforced by steel bars and half bearings.

The shafts were extended to give a bearing surface on each side of the gears. Then two steel bars were used to support a half bearing shell on the outer side of each shaft. This relieved the gear housing of all undue strain and reduced maintenance.

London, England. J. T. TOWLSON.

717. Driving a Broken Gear by Using Two Idlers.

A cast-iron gear was so badly broken that it seemed impossible to repair it. About one-eighth of the teeth were missing. To keep the machine in operation while a new gear was being obtained, we decided on a rather novel method of driving the broken gear. Between the driving and driven gear an idler gear was used, so we removed this and procured two old gears of the same pitch. Next, we cut off two steel straps and drilled one hole in the center to fit the fixed shaft on which the regular idler gear ran and two holes near each end to take two short shafts for the new idler gears. Pins through both ends of these shafts and a spacer between the straps on the idler gear shaft completed the assembly (Fig. 218).

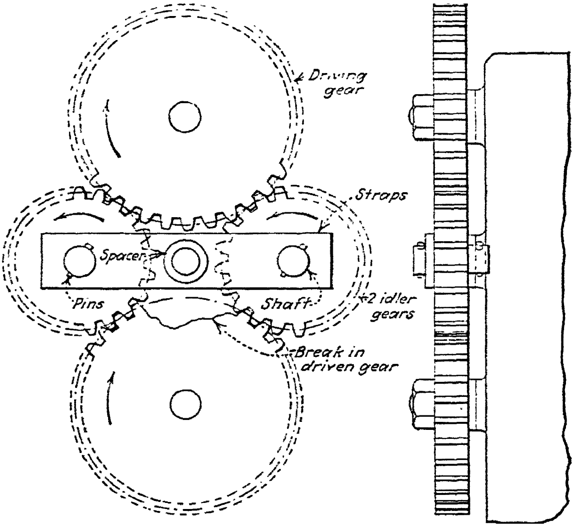


FIG. 218.—Broken gear kept in operation by using two idlers.

The broken gear was thus driven by the two idler gears, so that while the break in the gear was passing over one idler gear, the other idler was doing the driving.

Hamilton, Ont. A. KENDALL.

718. Device for Holding Silent Chain Taut While Replacing Links.

Figure 219 shows a little device that we recently made to facilitate replacement of links in silent chain drives. Removing a full link from a chain and inserting a half link on chains below 3 in. wide is not difficult, but on larger chains, especially if the distance between sprockets is considerable, the ends of the chain cannot be readily held up on the sprocket while inserting the liners and pins, and not infrequently the sprockets are inaccessible for this work.

The device illustrated permits the work to be done on the run of the chain between the sprockets and in a minimum of time. One end of each bar is made to fit into the chain link and is held in place by a pin inserted across the top of the chain. When the bars are in position, the slack in the chain is taken up by the turnbuckle, with the center bar and pins providing a fulcrum for the end pieces.

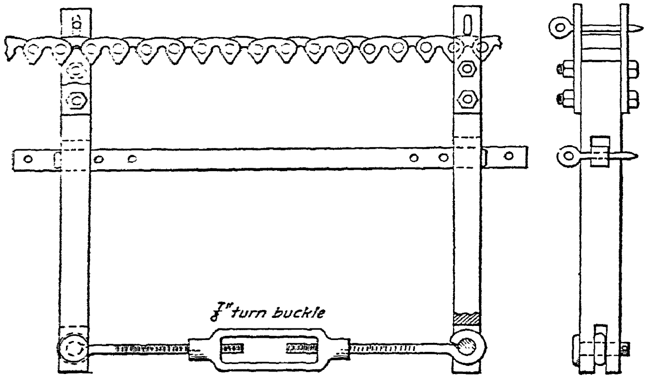


Fig. 219.—Holding device applied to chain while replacing links.

Philadelphia, Pa. E. B. West.

719. Increased Belt Speed to Increase Power.

In a mill, the elevator was driven from a line shaft in turn driven by a 6-in. belt from a second line shaft, as in Fig. 220.

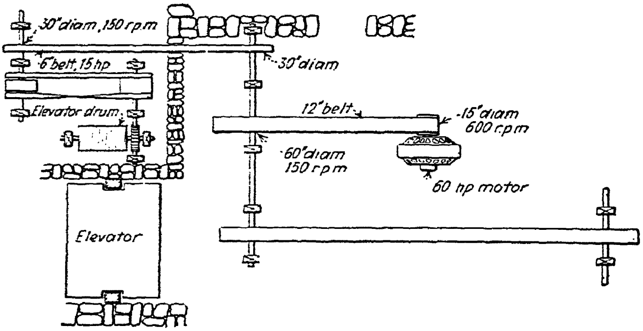


Fig. 220.—Setup in which belt-speed increase increased power.

Load was added to the line shaft driving the elevator until total load was about 35 hp. This raised the problem of how to transmit the increased power to the shaft.

The 6-in. belt operated on 30-in. pulleys and was good for about 15 hp. As belt width could not be increased conveniently, we decided to increase speed. On the 30-in. pulleys, belt speed was about 1,200 ft. per minute. By replacing the 30-in. pulleys with others 64 in. in diameter, belt speed was increased to 2,500 ft. per minute. This made it good for 35 hp.

Boston, Mass. C. W. PETERS.

720. Silent Chain Drive Changed to Belt Drive in Emergency.

A 20-hp. motor was mounted on the top of a machine, and drive was practically vertical, as shown at right (Fig. 221).

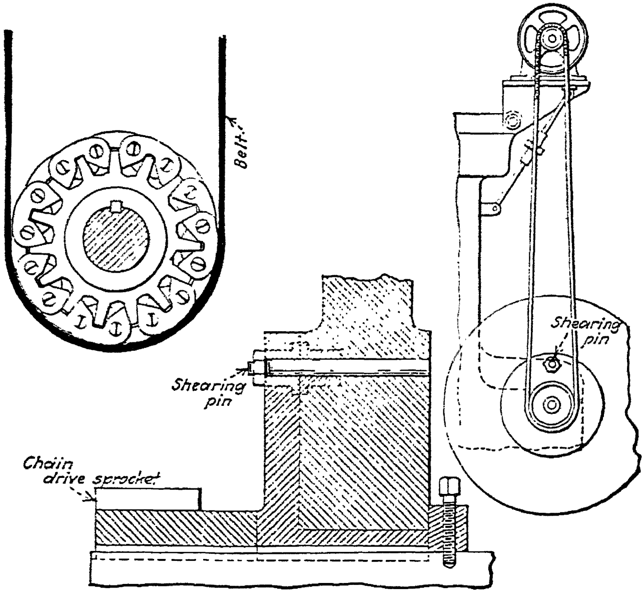


FIG. 221.—Arrangement of chain drive and shear pin.

The chain sprocket was arranged to drive the machine through a shear pin having a nut on the outer end (Fig. 221, below). The pin was a fairly good fit in the hole, and generally, when it did shear, the pieces would stay in place until the machine was stopped and the pieces withdrawn or driven out. On one occasion, however, for some unknown reason, the short end of the pin with the nut fell out when the pin sheared and dropped into the sprocket, causing serious damage to the chain over a length of about 40 in.

There was no spare chain in stock, and the machine had to be kept in operation.

Our maintenance man suggested wrapping each sprocket with a piece of the chain taken from the undamaged section and using a belt, as shown at left. With reduced output, the machine was operated with this drive for about a week.

Chicago, Ill. G. I. Williamson.

721. Protecting Belts Exposed to Weather.

Frequently, it is necessary to use belts outside buildings where they are not protected from the weather. A cover is handy for keeping rain off.

An ordinary iron gasoline or oil drum is cut into halves lengthwise with an acetylene welding torch. Each half is mounted to a support by riveting two strap hinges to its head and attaching them to the support, in a position such that when the half drum is turned down flat, it will completely cover the pulley.

Each belt is wound up, and the cover turned down over it every day when the mill stops and during rainstorms. It does not take long to prepare these covers, and the cost is small compared with that of maintaining or replacing belts exposed to the weather.

Cairo, Ga. L. M. Jordan.

722. Cold Glue Used as Belt Cement.

For many years in our plant, we used a leather-belt cement that was applied hot. One day a glued joint on the exciter belt broke, and, not having any regular belt cement on hand and needing the generator, I decided to try cold Russian glue. This is the ordinary kind of glue used for woodwork. It was applied to the belt with the hope that the joint would last until we could get some regular belt cement.

It is now two years since we made that joint, and there is no sign of weakening. The pulley on the exciter over which the belt runs is 4 in. in diameter and operates at 1,700 r.p.m. We have in the last year and a half made several joints on other belts with the same kind of cold glue, and all have been satisfactory.

Duluth, Minn. Nels Hilsen.

723. Another Comment.

Cold liquid glue for belts will be improved if a small quantity of potassium chloride is added. This prevents the cement from becoming so hard that it cracks.

Toronto, Ont. JAMES E. NOBLE.

724. Still Another.

Glue is a back number here, leading belt makers using celluloid varnish, either purchased as clear lacquer or made by dissolving celluloid chips in acetone. Its advantages over glue are that it is waterproof and has extreme flexibility and great tensile strength, nearly equal to those of leather. Rubber cement, made by dissolving crepe rubber in high-test gasoline, is sometimes used, but I have never had satisfactory results with it.

Where a belt has to be run in a steamy or damp atmosphere, and a rubber belt cannot be used to advantage, celluloid cement followed by a coat of celluloid varnish over the belt is recommended.

St. Louis, Mo. L. R. BAKER.

CHAPTER XII

BEARINGS AND LUBRICATION

725. Eliminating Oil Drip on a Revolution Counter.

This device (Fig. 222) effectively stopped an annoying creep of oil along the shaft of a revolution counter. The bearing extends from the back of the housing and is lubricated by oil running off a gear train. Before addition of the slinger and cup, excess oil would creep along the shaft to the coupling, then drop to the floor. Seepage now drips off the slinger into the cup and is returned to the sump through a small hole drilled for that purpose. The slinger is pressed on to the shaft from the coupling end.

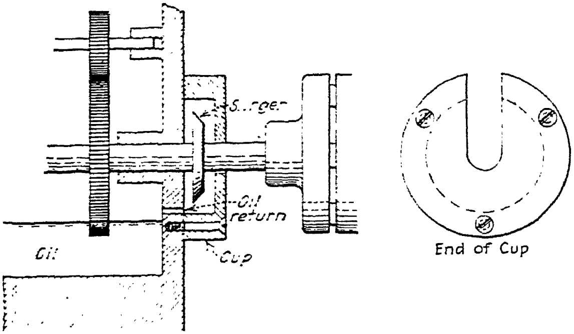


FIG. 222.—Oil slinger on shaft of revolution counter.

Madison, N. J. B. F. POWELL.

726. Bearing Cooled with Water.

The usual emergency treatment of a hot bearing is to let a small stream of cold water run on the shaft near the bearing. This is sometimes not easy to arrange with the usual pieces of heavier hose. A handy device is a length of automobile windshield-wiper tubing, a 7- or 8-ft. piece of which can be obtained in a ten-cent store.

The tubing, used as a siphon, can be held in position by a small wire bent and fastened to the bearing.

Missouri Valley, Iowa. FRANK W. BENTLEY, JR.

727. Continuous Supply of Cooling Water.

The principal objection to Frank Bentley's method for keeping a bearing cool is that the water is likely to become exhausted in a short time. I have placed a canvas belt on the shaft close to the bearing and allowed it to hang into a pail of cold water. As the shaft rotates, it causes the belt to move around on the shaft and carries water up on to it. With this method, there is no splashing of water, and it does not get into the lubricant.

Atlantic Highlands, N. J. M. M. GOOCH.

728. Lubricating Commutator Brushes.

In many cases where hard brushes have to be used there are considerable friction and screeching at the commutator. Performance of these brushes can be improved by lubricating them as follows:

Heat slowly to a dull red on an iron plate, then plunge in machine oil, where they remain until cool.

Another method is to boil the brushes in paraffin wax. This must not be heated by an open flame, for heated paraffin gives off inflammable vapors.

This treatment causes part of the oil to enter the brush but not enough to cause smearing of the commutator.

Brentford, England. W. E. WARNER.

729. Auxiliary Oil Duct Improves Bearing Lubrication at Starting.

When starting under heavy loads the main shaft on one of our pumps was noisy, vibrated excessively, and would quickly run hot. Each bearing was lubricated through two sight-feed lubricators, dripping directly on to the shaft through ½-in. holes in the bearing cap. Inspection showed most of the trouble to be at the bearing face *F* (Fig. 223), which took crank side thrust. This surface was normally lubricated by oil working out along the shaft from the nearer oil drip, but sometimes this flow failed, and trouble started.

The difficulty was overcome by drilling a ⅜-in. hole into the bearing cap 1 in. above the shaft and parallel to it, intersecting the first oil-drip tube *L*, passing through handhole *H*, and ending at the second oil-drip tube L_1. A pint of oil, poured into the handhole before starting the unit, will now reach both oil drips and overflow through hole *R* to lubricate the crank face.

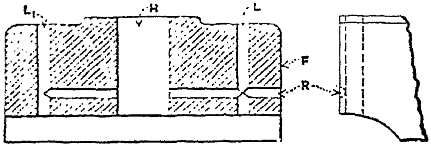


FIG. 223.—Auxiliary oil duct helps at starting.

Longview, Tex. ELTON STERRETT.

730. Making a Single-connection Lubricator Work Satisfactorily.

It has been my experience that a single-connection hydrostatic lubricator (Fig. 224, left) is always a source of trouble. It will feed oil properly when first started but soon slows down and stops until it is blown out and started again.

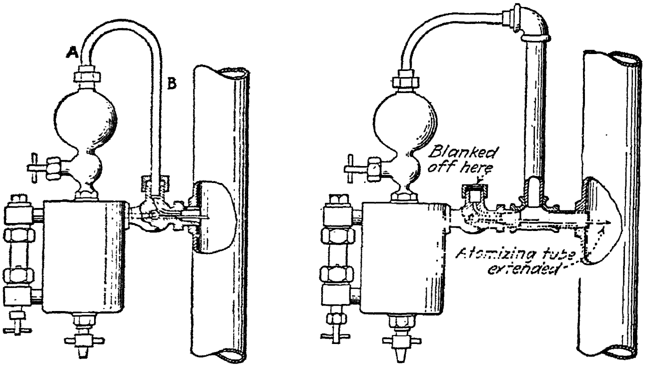


FIG. 224.—Original (left) and improved connections to lubricator.

When the lubricator stops feeding, it seems to be in a balanced condition, whereas it should have an unbalanced head of water in the condensation reservoir and vertical tube *A*, which forces the oil through the sight-feed nozzle. Apparently, the drop leg of the condenser tube *B* gets filled with water as well as section *A*, instead of being filled with steam.

I concluded that the water was held in the small-bore tube owing to surface tension of the liquid, which was sufficiently strong to prevent steam from getting into the tube to break the water column.

The lubricator was reconnected as shown in Fig. 2, ½-in. pipe and fittings being used. The atomizing tube was also extended to reach farther into the steam pipe. The lubricator has since operated satisfactorily.

Michel, B. C. THOMAS C. PORTEOUS.

731. Sawing Oil Grooves in Babbitted Bearings.

I took a couple of old power-saw blades, clamped them together, and ground clearance slots in them the proper depth and distance apart. With both blades mounted in a hack-saw frame, it was then a simple matter to saw the oil grooves in a number of bearings having an oil hole near each end (Fig. 225).

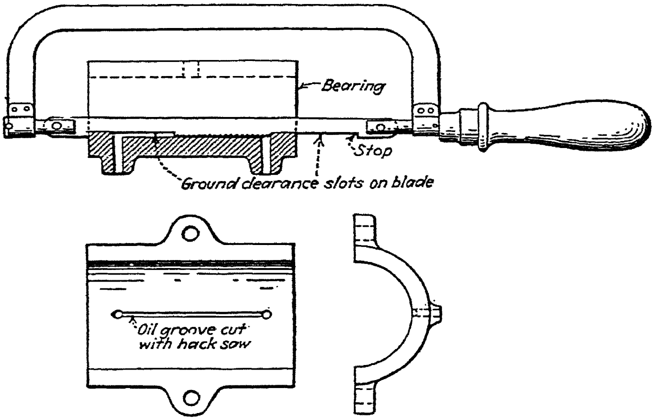


FIG. 225.—How the oil grooves were cut.

There is a certain knack in starting the cut, which consists in cutting with the back teeth of the saw until the cut is fairly started.

With a bearing having only one center hole, I first chip or drill small clearance holes at each end.

Hamilton, Ont. W. KENDALL.

732. Fire Risk from Lubricating Oil.

One lubricating oil pipe on a 5,000-kw. turbine-generator set started to leak where the pipe entered a flange. While the plant engineer was examining it, the pipe blew out of the flange, and the oil spurted on to a near-by 650°F. steam pipe. As the oil was pumped automatically, it, of course, pumped more oil as pressure fell. Steam temperature was sufficient to ignite the oil, and a small fire started. The flames caught some match boarding near-by, but fortunately the fire was put out before any great damage had been done.

This is not the first case in which fires have been started through similar causes. It is important that the lubricating oil piping on a turbine should be kept free from leaks and in good condition, and where they are run close to steam pipes carrying high-temperature steam, precautions should be taken against oil splashed on to them. The temperature at which the light lubricating oil used in turbines ignites will vary slightly with the grade of oil but is usually around 625 to 630°F.

Brentford, England. W. E. WARNER.

733. Stopping Lubricating-oil Trouble.

About three years ago, we purchased a 120-hp., four-cylinder two-cycle oil engine with force-feed bearings; the cylinders were 8¼ by 12 in. This engine started to pump lubricating oil past the oil rings and out the exhaust at the rate of 3 to 4 gal. every 24 hr.

I put a No. 500 cylinder hone in an electric hand drill and worked down all high spots in the cylinder, giving the cylinders a highly polished surface. This gave the pistons more clearance. Then the pistons had high spots ground off; also an extra oil grooving was turned above the old.

I then used hammered oil-slot rings in place of the grooved ring and added splash plates fastened to the doors of the crankcase.

This engine now operates with about 0.75 gal. of lubricating oil for the crankcase and cylinder lubrication per 24 hr.

Baltimore, Md. GEORGE WIRKOW.

734. Improved Hydrostatic-lubricator Operation in Cold Weather.

A steam-cylinder-operated elevator was located in an unheated isolated part of an industrial building. For convenience, the steam-valve lubricator was mounted some distance away. In cold weather, the oil congealed in the feed line from the lubricator to the steam valves and would not flow satisfactorily.

This difficulty was reduced by connecting a ½-in. pipe from the feed line just off the lubricator into the steam main about 15 ft. from the lubricator steam tap, as in Fig. 226. Because of friction loss, there was several pounds pressure difference in the steam main between the two ½-in. connections each time the elevator was operated. This served to establish an oil flow each time the steam valve in the elevator opened. Also, there was a slight pressure drop between the pressure line to the lubricator and the new ½-in. line installed. This prevented the pressure from backing up through the lubricator and interfering with proper operation.

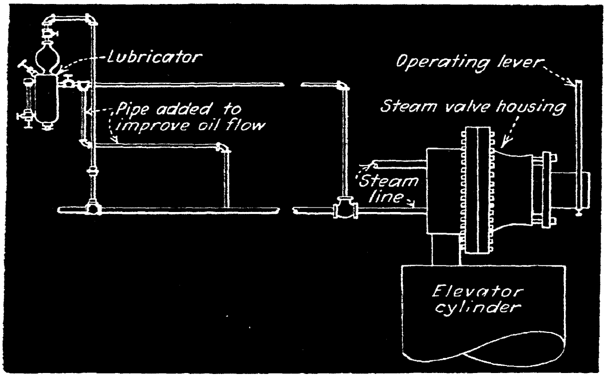


FIG. 226.—Pipe from feed line establishes oil flow.

Waterville, Maine. HARRY M. SPRING, JR.

735. Why Cut Useless Oil Grooves?

Designers, mechanics, inspectors, and erectors are prone to overlook the fact that to make oil grooves of value, they must have a generous bevel on the leading side.

This permits oil to be drawn from the groove to form an oil film between the rubbing surfaces of the shaft and bearing. Figure 227-1 shows a common, but improper, form of oil groove;

and Fig. 227-2, the proper form having a long, tapered leading edge to draw the oil in between the shaft and bearing.

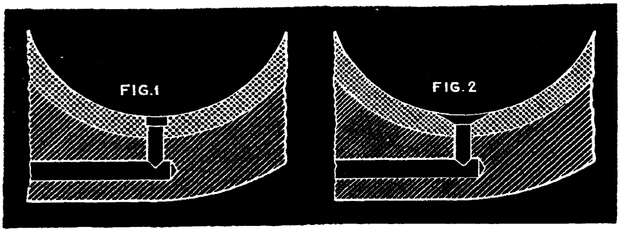


Fig. 227.—Forms of oil grooves, incorrect on left.

Sherbrooke, Que. G. F. McClay.

736. Lubricator from Pipe Fittings.

While I was operating a plant in an isolated locality, the body of a lubricator burst. Several weeks would be required to obtain a new one, so it was decided to try to make a new body and mount the old fittings on it. As shown in Fig. 228, the new body for the lubricator was made from a piece of 3-in. pipe, 6 in. long, with a cap on each end. These were drilled and tapped, and the fittings of the old lubricator mounted. This makeshift operated satisfactorily for over a year.

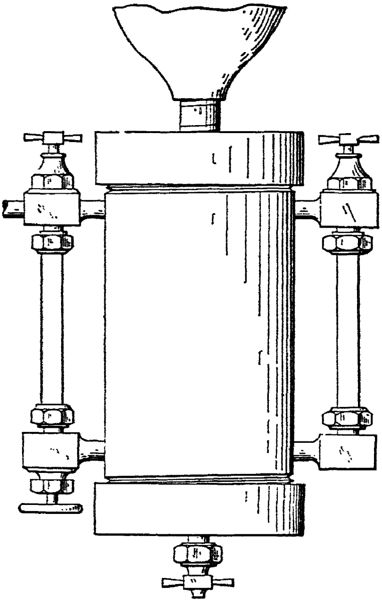


Fig. 228.—Lubricator made from pipe fittings.

Nelsonville, Ohio.

R. Rohe.

737. Convenient Method of Recording When Bearings Are Lubricated.

I use this way of keeping a record of the oiling and greasing of motors and miscellaneous bearings: One bolt or cap screw that holds the end bell or bearing cage is drilled through the head to take a small wire. A strip of tin is stamped with the figures corresponding to the date of greasing or oiling and wired to the bolt. No marking up of walls with chalk is necessary, and it can be read at a glance.

Abras Grandes, Cuba. THOMAS C. HULTON.

738. Cable-oiling Device.

The wheels are discarded trolley wheels, and the tanks discarded oil cans. The oiler lubricates hoisting cables in a mine, the method being considered more advantageous than applying cable grease, wasteful of both time and material. Black oil has been found to be satisfactorily penetrating. The supply is regulated by a pet cock to which is fitted a nipple and piece of hose. The nipple is soldered to the bottom of the tank, which rests on two thin wooden wedges.

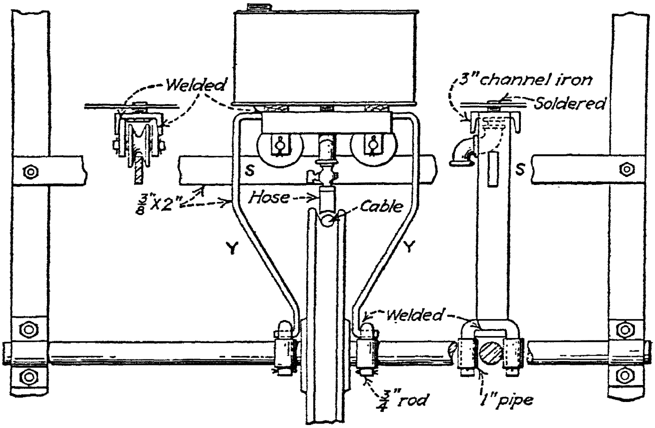


FIG. 229.—Details of traveling cable oiler.

Located on the first pulley stands from the engine house, where the "whip" in the cables is practically nil, the oiler rides on a rail made from a piece of 2⅜ in. flat iron guided by the sheave through the yoke *Y* (Fig. 229) which is slotted at *S*, thus following the rail.

To prevent scraping of the axle, the yoke is fitted with two pieces of 1-in. pipe which roll against the axle.

Feed, of course, is adjusted according to the length of cable and the frequency in motion.

Ironton, Minn. AXEL LEKSTROM.

739. Lubricator Repaired with Paper and Shellac.

When a wild wrench one day ended its flight against a glass lubricator body, repairs were in order. The lubricator served the crankpin bearing of a crude-oil pump on 24-hr. service, seven days a week, and a spare glass was not to be obtained within hundreds of miles. An emergency repair was imperative, but at first there seemed to be no substitute offering the desired visibility.

The shattered glass body was used without dismantling. A paper cover was cut to go over the shattered section, with a $\frac{1}{4}$-in. margin all around. After the glass was cleaned with gasoline and allowed to dry, one side of the paper was shellacked and smoothed down on the broken section, care being taken to work out all air bubbles. A coat of shellac brushed over the outside waterproofed and reinforced the job.

Longview, Tex. ELTON STERRETT.

740. Oil Grooves Stop Oil Leakage.

We found that oil grooves cut in the bearing housing around the shaft permanently stopped oil leakage. Figure 230 shows how these grooves are cut. The grooves are $\frac{1}{8}$ in. wide and about $\frac{3}{16}$ in. deep. If the diameter of the shaft is D, the grooves are cut to a diameter of $D + \frac{3}{8}$ in. There should be at least two oil grooves. A $\frac{5}{32}$-in. hole should be drilled in the housing, as shown. Oil carried along the shaft is thrown off into the grooves

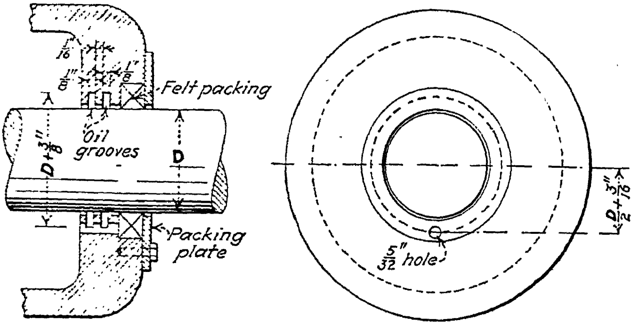


FIG. 230.—Location of oil grooves cut in bearing housing around shaft.

by centrifugal force. As the oil accumulates, it flows to the bottom by gravity and runs back into the bearing through the hole. The walls between the grooves need be only 1/16 in. thick. In case there is not sufficient stock in the housing to allow for cutting oil grooves, it is recommended that the housing be rebored to take a bushing sufficiently long for the grooves.

Tests have shown that with oil grooves no oil leaks out along the shaft even when felt packing is not used. However, felt packing and packing plates are used to keep dust and dirt out.

Worcester, Mass. DAVID FLIEGELMAN.

741. Alarm System for Float Switch.

We have a reserve oil tank for bearing oil supply which floats in on the pump line. In case the pump stops, the reserve tank keeps oil flowing while the engineer is restarting the pump. The tank has capacity to supply oil to the bearings for over an hour if necessary.

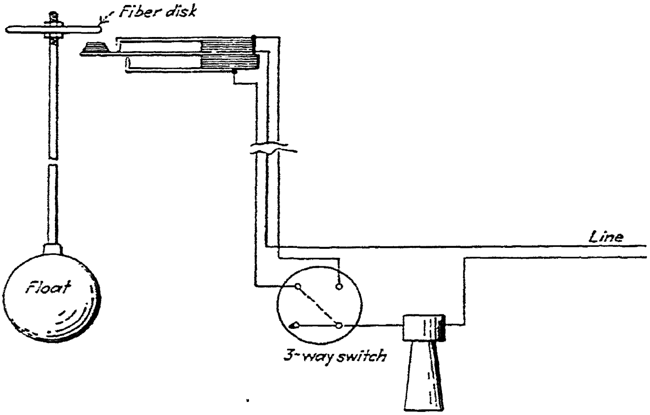


FIG. 231.—Arrangement of float switch and alarm.

This float switch (Fig. 231) was made on the job and is set to blow the horn as soon as the oil level in the tank drops about 4 in. The fiber disk presses down on the extended switch arm, which interrupts the upper contact circuit and closes the bottom circuit, blowing the horn until the three-way switch is operated to stop it and automatically cutting in the upper contacts. When the tank is nearly full, the upper contacts will reclose and blow the horn again, warning the engineer that the tank is almost full. The three-way switch must again be operated to stop the horn and put the circuit in operating condition for the next pump failure.

Shaded portions of the switch indicate insulation. We used $\frac{1}{2}$-in. bakelite, but hard fiber would be satisfactory. Contact strips are $\frac{1}{4}$ in. wide by $\frac{1}{16}$ in. thick spring brass and are mounted on the bakelite with small brass machine screws (not shown) long enough to serve as a binding post for the connection. The extension of the middle strip has an insulated contact surface secured to the metal with machine screws tapped into the material; however, it is not necessary to use an insulated disk on the float rod.

Nashville, Tenn. T. E. MILLER.

742-745. Four Hot-weather Lubrication Hints.

Lubrication troubles may be expected to increase somewhat during the hot summer months on account of the decreasing viscosity of the oil with increasing temperatures. Here are four tips on hot-weather lubrication:

742. The effect of summer temperatures is less important, of course, where a circulating system is employed to insure an adequate and continuous flow of oil. It is often well with such systems, however, to increase the circulation during the hot weather.

743. It is particular important to test all oils for emulsification with water. The highly fatty oils used in steam cylinders have a way of working into the circulating oil supply, causing it to emulsify with the water to an objectionable extent. Proper filtering will extend the life of an oil enormously.

744. I recall many instances where flashovers of synchronous converters caused incessant trouble with bearings, as the heavy current rush from the brushes to the shaft and thence to the pedestal, frame, and earth caused rough spots in the bearings and led to a shutdown. This problem was finally solved by placing a couple of rings on the shaft and grounding the shaft to the machine frame with a conductor of ample capacity. In this way, any flashovers or short circuits to the shaft are carried off directly through the conductor instead of breaking down through the oil film in the bearings.

745. The possibilities of deflocculated graphite for emergency bearing troubles are not fully appreciated. A little graphite fed to the bearing so that the rotating shaft draws it in will frequently enable a hot bearing to cool down sufficiently to remain in service until attention may be given to it. The graphite fills up the pores in the bearing metal, thus lowering the coefficient of friction and heating. Moreover, it helps to maintain the oil film between bearing and shaft, especially when the viscosity of the oil has decreased on account of high temperatures. It is important not to use too much graphite, however; otherwise the oil pipes may become clogged up. About one-half of 1 per cent by bulk of graphite will usually be found sufficient. I have also found graphite useful in other instances, such as when starting new machinery.

Chicago, Ill. M. C. LANGFELDER.

746-750. Five Ways to Prevent Antifriction Bearing Trouble.

A large part of the trouble experienced with antifriction bearings is due to the designer's shortsightedness. In other instances, bearings have been abused by operating men.

746. Lubrication depends upon load, speed, amount of dirt, and temperature. There is no well-defined speed above which oil should be used or below which grease should be employed, because the lubricant serves the four functions of preventing rust and corrosion, minimizing friction, dissipating heat, and forming a supplementary seal between rotating and stationary elements.

747. Not nearly enough attention is given to choice of lubricant. After the first change or two, when the lubricant recommended by the manufacturer of the bearing may be used up, new lubricant may be chosen on the basis of cost. Only pure mineral grease or oil should be used, consistency depending upon speed, load, and temperature. The lubricant should not absorb moisture, which causes corrosion. Nor should it contain any solidifying matter, which may tend to clog the bearing and cause unnecessary wear and friction. The lubricant should be free from materials that tend to create a lapping action, which leads to rapid deterioration. Where high speed and temperatures have to be contended with, it is important to employ a grease which will not break up and force the oil from the bearings or form a gummy residue that may clog the rollers or balls and rupture the race.

748. Adequate seals are available to prevent loss of lubricant due to leakage or vaporization. The bearing manufacturer has the choice of cork, felt, leather, and various forms of labyrinths. By means of these, antifriction bearings may be made oil-tight during the life of the bearing. Oil seals are frequently omitted, however, because the designer has not left space for a bearing with an oil seal. Bearings with oil seals require 30 to 50 per cent more space. Oil seals are often omitted because they add approximately 15 to 25 per cent to the cost of the bearing. For some classes of service an oil seal will ordinarily pay for itself within a year in lubrication saved, besides preventing damage to equipment. Designers may overlook advantages of the oil seal in their effort to keep down price. The operating engineer should insist upon oil seals where they are required.

749. Another cause of trouble with antifriction bearings is grit, dirt, and corrosion. Antifriction-bearing manufacturers carefully cover bearings with oil and seal them before they are put into stock or leave the plant so that they cannot collect dirt or be attacked by the acid or moisture in the atmosphere. It is surprising how rapidly the highly polished surfaces will pit if the bearings are exposed. Notwithstanding this, spare bearings are often left exposed in plants where the atmosphere is corrosive. Frequently the wrappers in which bearings are shipped are broken or removed. The grease with which the bearing was carefully covered is rubbed off.

750. Higher motor speeds introduce additional problems. If everyone responsible for application, installation, and operation will bear in mind five simple yet basically important requirements, the majority of antifriction bearing troubles will disappear. These are

(1) proper-size bearings; (2) proper-type bearings; (3) mount properly; (4) lubricate properly; (5) maintain properly.

Chicago, Ill. ELMER ZITZEWITZ,
Chief Engineer, Aetna Ball Bearing Manufacturing Co.

CHAPTER XIII

PIPING, VALVES, AND FITTINGS

751-757. Seven Notes on Piping Installation.

751. When any large amount of piping is to be installed, considerable saving can be effected by a little planning before the work is turned over to the pipe-fitting department. In larger sizes of piping, say 4 in. and over, welding can be substituted for cast-iron fittings. Two 45-deg. welds will make an efficient and practical turn. Also, in some of the smaller runs of piping, welds may be used; but it should be borne in mind that sufficient unions must be used to permit of pulling any separate piece of pipe or valve out of the line. Fittings are available made from seamless pipe in the form of bends in both 45- and 90-deg. angle patterns. As far as the cost is concerned, when two welds, either in the line or to a steel flange, are considered, there is not much to be gained by the use of these bends; but in an installation where there is an objection to cast-iron fittings, bends are most useful. When they are properly welded in a line they make a neat-appearing job, and by using two 90-deg. turns a short-radius return bend is obtained.

752. Where there is a long run of pipe of a larger size, the plain-end pipe with welded joints will give a considerable saving over pipe that has to be cut and threaded. Where cast-iron pipe or flanges are not permissible, steel-welded hub flanges are usually resorted to. These are of forged steel with a short beveled hub and come in various drillings, one series corresponding to standard and another to extra-heavy drilling.

753. Where other than standard pipe is in use, such as casing, light-weight pipe and "hen skin" (a steel flange) can be obtained which are bored to fit the casing and suitable for welding on to it. These flanges are widely employed where it is necessary to connect light-weight pipe to standard valves and fittings.

754. Where there is a large amount of light-weight pipe in a system it is a good plan to save short lengths and periodically send them to the welding plant or source of supply and have them welded up ready for use.

755. The Van Stone, or loose-ring, flange is also available with a small hub, or welding lip, so that the whole can be attached to off-standard pipe.

756. Where two different diameters of pipe are to be joined together, in the smaller sizes, bushings, especially on high pressures, are not recommended. It is much better to use a bell reducer; better still, a swedged nipple. Many of the large oil companies prohibit the use of bushings, on the ground that, if employed for low pressures, they may inadvertently be put on high-pressure lines.

757. Although the application of reducing flanges is general, if space allows it is better to use a swedged nipple and two flanges. In large pipe, a neat swedge may be made by slotting back the larger pipe for about three diameters with a torch, then heating the remaining sections and bending them in until they assume the diameter of the smaller pipe, when they are welded together and then around the circumference on to the smaller pipe.

Long Beach, Calif. M. C. Cockshott.

758. Form for Bending Pipe Hangers Fitted to Anvil.

In construction or maintenance of a power plant, the blacksmith is called upon to make a large number of pipe hangers, or brackets. The usual procedure is to have a helper hold a pipe, around which the iron is bent, on the anvil as a form.

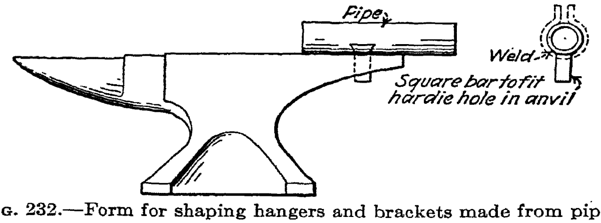


Fig. 232.—Form for shaping hangers and brackets made from pipe.

As an improvement, we welded on to a 4-in. section of the pipe a square bar 2½ in. long, fitting the hardie hole in the anvil (Fig. 232). This arrangement freed the helper, allowing him to drill the completed hangers, and at the same time facilitated the smith's work.

The saving in time was so marked that a six-piece set, ranging from ¾ to 3 in., was made up of cold-rolled stock as permanent shop equipment.

South River, N. J. LOUIS A. BENTON.

759. Improvised Hanger to Support Staging While Erecting Pipe Lines.

We recently ran several pipe lines along the sides of our building. The length of the run was too great to build a staging to put up the hangers and erect the pipes and cover them, so we devised the hangers illustrated in Fig. 233. These were made to be suspended from the bottoms of the windows and permit the windows to be nearly closed when they were in place.

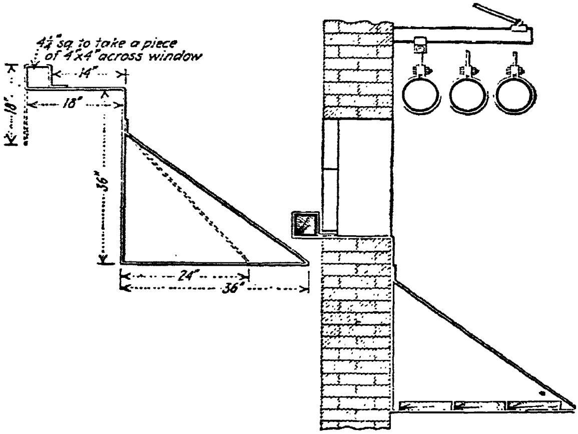


FIG. 233.—Staging suspended from windows.

The original hanger was made to hook over the wall under the window, as shown by the dotted line in the detail. Numerous obstructions, however, such as piping and benches, made it difficult to use the hangers, so they were changed, as shown by the solid lines. The improved model has a loop through which a piece of 4- by 4-in. timber is placed. The hanger was also made wider.

Watertown, Mass. THOMAS A. WALSH.

760. Handy Pipe-measuring Tool.

A piece of hardwood 2 in. thick is turned to give a circumference of 1 yd. Then two 2-yd. tape measures are glued on the wheel, one at each side, with the scales running in opposite directions. Next, a sheet-metal indicator, cut to clear the wheel at the bottom and pointed on both sides at the top to indicate the inch marks, is placed over the wheel. The handle is made of ⅜-in. rod bent to the shape shown in Fig. 234, and the ends sprung into the hole in the center of the wheel after the indicator is in place. To measure the length of a pipe, the wheel is placed at the end with the zero mark on the scales in line with the indicator points. Then the wheel is rolled along the pipe, and the number of revolutions and the odd feet and inches noted. The indicator is a loose fit on the handle, so it always points straight up and is not affected by the position of the handle.

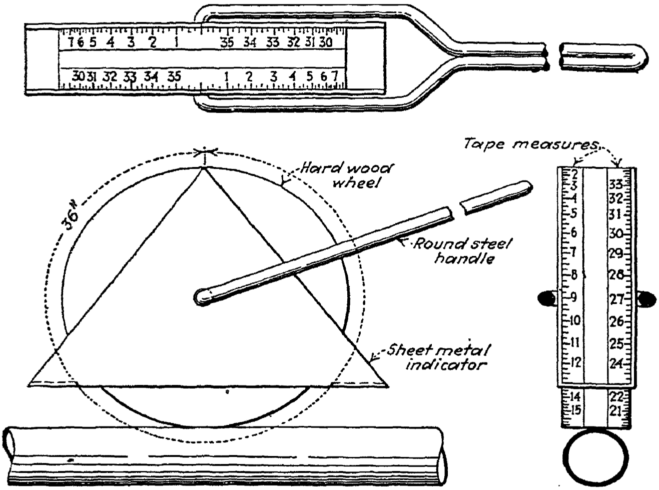


FIG. 234.—Details of pipe-measuring tool.

Hamilton, Ont. H. MOORE.

761. Use of Asphaltum Paint on Pipe Joints.

We were installing some new piping and ran out of red lead. I started looking over the stock to see what would do instead. I found a can of black asphaltum paint and told the workmen to use it. The results were surprising; the joints stood up from six to nine months instead of the three or four, as when red lead was used. I now have pipe joints that have been in service nearly a year without any sign of a leak.

My method of applying the paint on these joints is: After the pipe is threaded, wash the threads with gasoline to remove all the oil and wipe perfectly dry or, better still, let them dry in the air. I have had the same good results with ground unions. First wash with gasoline, wipe perfectly dry, paint both sides, and put them together without turning the joint if possible. I now use the paint on all joints. The joints will come apart as easily as when red lead is used.

Buffalo, N. Y. H. F. MOORE.

762. Pipe-jointing Compound.

A compound which I have tried out on lines carrying both steam and hot water at 150-lb. pressure serves as a combination lubricating, grinding, filling, and nonhardening pipe-joint dope. The maker boasted of never having a joint leak, irrespective of pressure, on iron or brass pipe if the pipe and fitting threads were in reasonably good condition. Furthermore, the joint could always be separated with comparative ease after long service. The compound consists of a mixture of five parts by weight of powdered graphite to one part by weight of finest flour of emery made into a fairly thick paint with cylinder oil, the paint being used on the male threads only.

Toronto, Ont. JAMES E. NOBLE.

763. "Smudge."

Lampblack, glue, and water well boiled is what plumbers call "smudge" and is used for painting parts of a lead pipe or sheet surface or other metal surface, to which they do not want any solder to stick or attach itself.

Chicago, Ill. J. THORN.

764. Bending Copper Pipes.

In every power plant, there are always a number of small-diameter copper pipes which are used principally for conveying lubricant and instrument piping. The necessity for bending such pipes is of frequent occurrence, and when bending it is important that the cross section of the pipe remain unaltered.

Before starting to bend pipe, it is necessary first to anneal it by heating it to a cherry-red color and allowing it to cool normally. The pipe should then be filled with pitch, resin, or sand. Where sand is used for filling, previous annealing can be dispensed with, but care must be taken that afterward every trace of sand is removed. I have found that the easiest way of bending is by means of a cylindrical piece of hardwood about 2 in. in diameter and 4 in. long.

In this wood are cut grooves which will take any of the variously sized pipes to be bent. This piece of wood can be held in a vise, and the pipe curved around it. If the curving is done carefully, the cross section of the pipe at the curve will not be altered.

If a dent has to be removed from a curve, the best way is to fill the pipe and tap around the dent with a wooden mallet, at the same time putting pressure on the filler so that the dent is pushed out. The same method can be used to restore oval pipes to a round section.

Welwyn, England. W. E. Warner.

765-768. Four Points on Removing Dents from Copper Pipes.

765. To straighten out and remove dents in copper pipes of comparatively small diameters, obtain a number of steel balls, highly polished and equal in diameter to the inner diameter of the tubing. Anneal the copper in the dented portion by heating it to a dull red and either allow it to cool down gradually or plunge it into cold water. Drive the steel balls through the entire length of the pipe. A little powdered graphite sprinkled among the balls in the pipe will facilitate the work. Obviously, if the balls can be made to pass through the pipe or tube, the latter will be restored to its original shape.

766. Dents on copper pipes which will permit a suitable iron or steel tool to enter can be straightened out by hammering or malleting, the projecting dents inside the pipe being forced back by placing the pipe on the tool and manipulating the hammer or mallet so that while the dent rests on the tool the blows will be delivered on each side of it or around it.

767. In cases where copper pipes are bulged on the outside, obtain an iron or steel plug and place it in the pipe to serve as an anvil while hammering or malleting the bulge back to the original shape. Anneal the damaged portion of the copper pipe as previously described.

768. Although a badly ruptured copper pipe can be repaired with a specially made copper welding rod containing a suitable deoxidizer, various tests have shown that modern high-strength bronze welding rods produce not only sound welds but also a weld metal that is tough and of good wear-resisting properties.

Manchester, England. E. ANDREWS.

769. Practical Pipe Repair.

A small manufacturing plant obtained its water supply through a 4-in. pipe which entered through a solid concrete foundation wall. One night the pipe developed a leak, and it was found to have split in the weld for about 8 in., beginning at a point about 2 in. from the wall.

The engineer decided that it would be inadvisable to repair the pipe by cutting it and rethreading the section in the wall, as the pipe might not stand up under threading. A sleeve 12 in. long, cut from a piece of 6-in. pipe, was slipped over the leak and supported temporarily in position by three short rods of such diameter as approximately to center the sleeve on the pipe. A special calking tool was then made, and the space between the pipe and sleeve calked tight with lead wool, the rods being removed when sufficient lead had been put in to hold the sleeve in place. This made a practical and satisfactory repair.

Indianapolis, Ind. J. F. HOBART.

770. Inaccessible Pipe Was Repaired with a Welding Torch.

A pipe in an inaccessible place aboard ship failed, and to renew it, if pipe had been available, would have taken a couple of days. Fortunately, a short section of pipe the same size was found in a scrap pile. This short section was split in halves lengthwise. The half that went against the side of the ship was beveled on the inside, then it was set in and welded in place, butting both ends against the old section of pipe. The welding had to be done from the inside because there was not room enough to do it from the outside. After this half shell had been welded in place, the other half was placed against it and welded in from the outside. A tight job was made, and it required much less time than if a new section of pipe had been put in.

Roselle, N. J. P. W. Lamson.

771. Welded Pipe Tested for Restricted Cross Section.

Here is a "wrinkle" that is extremely simple and rapid in testing small-diameter welded pipe for restriction of area:

By trial, a steel marble is found which will just pass through the normal bore of the pipe. This marble is inserted in one end of a pipe-coil section, an air hose coupled to that end, and the compressed air turned on, which literally shoots the marble through the coil.

This test was the means of finding restrictions in several coil sections. These were rejected and returned to the pipe-bending shop to have defects remedied. After field welding of the sections, a marble is shot through each complete unit in the same manner prior to the customary hydrostatic testing.

Arlington, Mass. Theron W. Bean.

772. Effective Packing Gland of Standard Pipe and Fittings.

At the junction of manifold line and exhaust duct, this packing gland was assembled as follows:

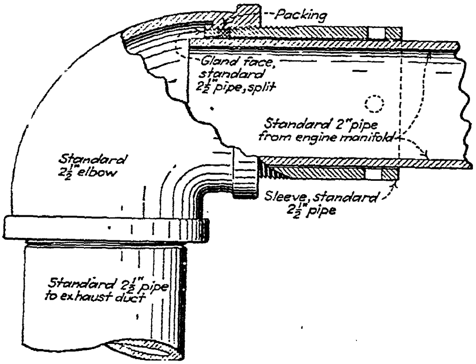

Packing
Gland face, standard 2½" pipe, split
Standard 2" pipe from engine manifold
Standard 2½" elbow
Sleeve, standard 2½" pipe
Standard 2½" pipe to exhaust duct

Fig. 235.—Details of packing gland for exhaust line.

A section of 2½-in. pipe, approximately two threads in length, was split and screwed into the elbow until held only by about 1½ threads (Fig. 235). The unthreaded end of the 2-in. line telescoped by a half nipple of 2½-in. pipe was inserted in the elbow and made up at the engine end. Woven asbestos packing was then placed in the space between the 2-in. pipe and the elbow inlet, and the whole was compressed and made gastight by drawing the sleeve snug with a spanner wrench.

In addition to furnishing a simple, cheap, gastight joint, this packing gland provides for elongation and contraction of the engine exhaust line without transmitting any attendant stress to engine or engine mounting. Ten such glands have been in almost daily use during the past two years without adjustment.

Bethlehem, Pa. G. B. Thom,
Department of Mechanical Engineering, Lehigh University.

773. Telephone Receiver Locates Underground Pipes.

It is sometimes necessary to locate a water pipe buried several feet in the ground. Rather than explore with pick and shovel, a simple device of the type shown in Fig. 236 can be used to determine the pipe's location within 1 ft.

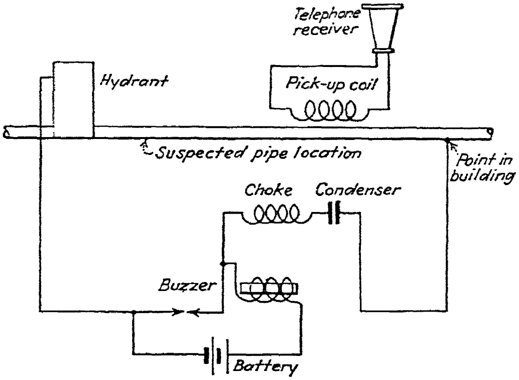


Fig. 236.—This simple device will locate underground pipes within 1 ft.

A pulsating current generated by a buzzer is passed through the pipe. A pickup coil, consisting of several hundred turns of No. 28 wire, wound on a 2-ft.-square wooden frame, in series with a telephone receiver, is used to locate the high-frequency current. The sound in the telephone is most intense when the coil is nearest to the pipe.

The condenser and choke coil are of such values that they are tuned to the buzzer frequency. For a 500-cycle buzzer, values of

0.5 mf. and 200 millihenrys may be used. The lead from the fire hydrant to the buzzer should be at least 20 ft. from the suspected pipe location to avoid interference.

Westfield, N. J. GORDON R. HAHN.

774. Stopping Vibration of Steam Pipes.

In Fig. 237, showing a part of the piping in our old steam-power plant, *A* represents a 15-in. steam header in the boiler room; and *B* and *C*, 8- and 6-in. steam pipes in the engine room. These were taken off the top of the header and connected to the engines in the usual manner. The engine room was large and high, and the engines were far from the steam main. The pipes were hung from the rafters, so that considerable vibration developed when the engines were running. Vibration in the horizontal runs was stopped by strapping the pipes together by coiled iron rods (not springs) to permit any necessary flexibility. Then the 6-in. drop *E* to the engine was strapped in a similar way to a near-by wall, and vibration was stopped completely.

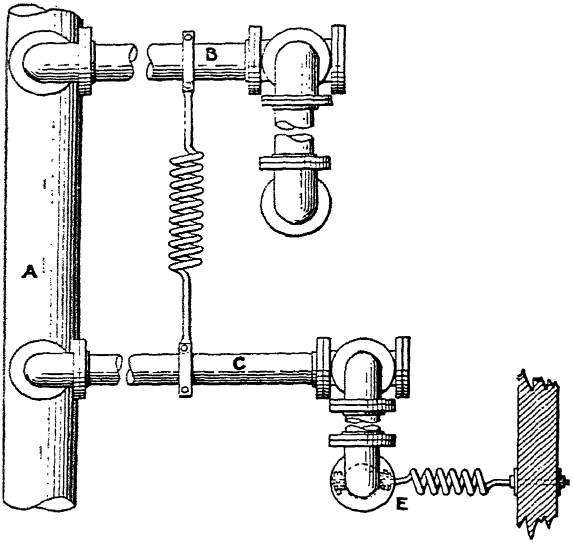


FIG. 237.—Pipes strapped together by coiled iron rods to stop vibration.

Chicago, Ill. P. L. WILLIAMS.

775. A Modified Steam Loop.

The illustration shows a loop used to lift condensation from low-pressure steam mains in tunnels and discharge it into return pipes at a higher level. These tunnels were built in low ground near the permanent water level.

The pitch of the main was 2 in. in about 750 ft. That of the branches was about the same. Loops were used to drain both the main and the branches. The condensers were made of 2-in. pipe and pitched return bends and hung upon the wall.

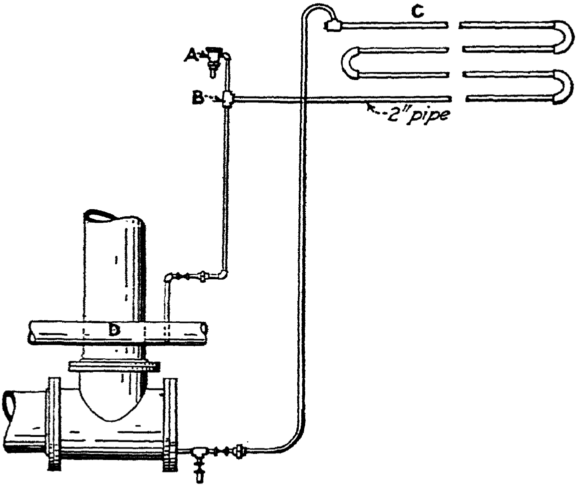


FIG. 238.—Modified loop used to lift condensation from lower to higher level.

An air-line valve *A* (Fig. 238) was connected to the upper end of a bull-headed T *B* on the discharge end of the condenser *C* to remove the air and noncondensable gases. The lower end of the T was connected to the return pipe *D*. For permanency, a 1-in. brass nipple was screwed through the top of the return to within ¼ in. of the bottom of the pipe, thus water-sealing the nipple. Exhaust steam is used for other purposes than heating buildings, so the loops must work continuously. This they do whether the steam pressure is above atmospheric as in winter or below it as in summer.

Elgin, Ill. W. L. PARKER.

776. Flashlight Finds Heat Leaks in Steam-pipe Insulation.

One of the troublesome jobs in a power plant is that of locating heat leaks in insulated high-pressure steam lines high above the floor. In our plant, there is considerable vibration from the machinery overhead, and the insulation cracks rather frequently.

We devised a new method that enables us to find the leaks in a few minutes, without a ladder. A flashlight is employed, with its lens removed, and the curved mirror shut off by a disk of black cardboard, so the bulb alone shows.

Streams of heated air, issuing from cracks, refract light rays much less than does cold air, and when light from a point source falls on them, they throw dancing, shimmering shadows. The intensity of shadows, it seems, is about proportional to amount of heat dissipated. Thus every crack or defect in the insulation is noticeably marked by a stronger shimmering display and can be almost instantly located.

Leningrad, Russia. LEON J. ISRAILEVICH.

777. Proper Installation of Steam Gaskets.

The view at *A* (Fig. 239) shows a typical incorrect method of installing gaskets on a steam-pipe companion flange. A large piece covering the entire flange face is cut, and the bolt holes punched. Flange bolts are pushed through the gasket and hold it in its correct position until the other flange is bolted fast.

B shows the proper method of installing a gasket. A ring is cut of not greater diameter than the inside tangent circle to the bolt holes, and small ears are left by which it may be located.

Advantages of this method are: First, it saves, on a 6-in. pipe flange, a ring of packing 9-in. in diameter and 1½ in. in width, or about 42 sq. in. Second, gasket *B* is more effective than gasket *A*, for two reasons:

In gasket *A*, the packing beyond the bolt holes is useless, because any escape of steam will take place through the bolt holes between the bolts and the flange. By reason of the smaller area of gasket *B*, the unit pressure on it which may be produced by the bolts is more than doubled, and the chance for rupture under high pressure is considerably reduced.

An easy way of placing this gasket is to line up the bolt holes, slip in half of the bolts around the bottom, separate the flanges just enough for the gasket to be slid in with the help of the ears to guide it and then tighten a couple bolts enough to secure it

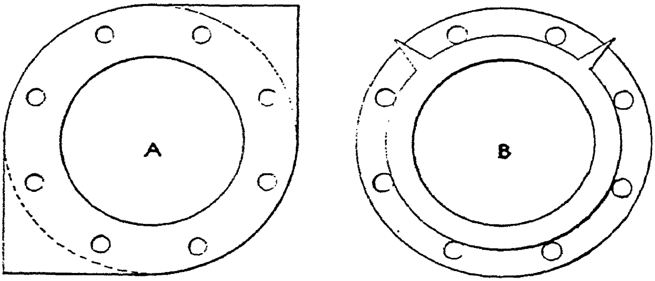


FIG. 239.—Incorrect and correct methods of installing pipe gaskets.

from slipping. The remaining bolts may then be put in and tightened up.

Butler, Tenn. W. S. WHITING, JR.

778. An Easy Way of Placing Soft Rubber Gaskets in Big Pipes.

Recently we had to change several pieces of 14-in. water line and renew some gaskets on the same line during a limited time.

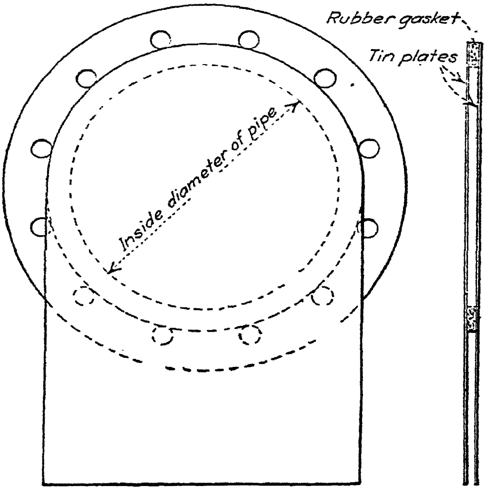


FIG. 240.—Gasket held between thin metal plates goes in easily.

Everything went well until we wanted to put in the new rubber gaskets.

As the space between the flanges was small, we had difficulty in getting the soft gaskets into place, until one of the pipefitters suggested that we cut two tin plates (any thin sheet might be used) of the shape shown in Fig. 240.

We put the gaskets between the two sheets and found it very easy to place the whole thing between the flanges. The sheets were taken out one at a time without affecting the position of the rubber joint.

La Plata, Argentina. ADOLF VON EUW.

779. Improvised Pipe-flange Gasket.

About a year ago, I experienced some difficulty in making up a 6-in. elbow to a nonreturn valve. Figure 241 shows how the difficulty was overcome.

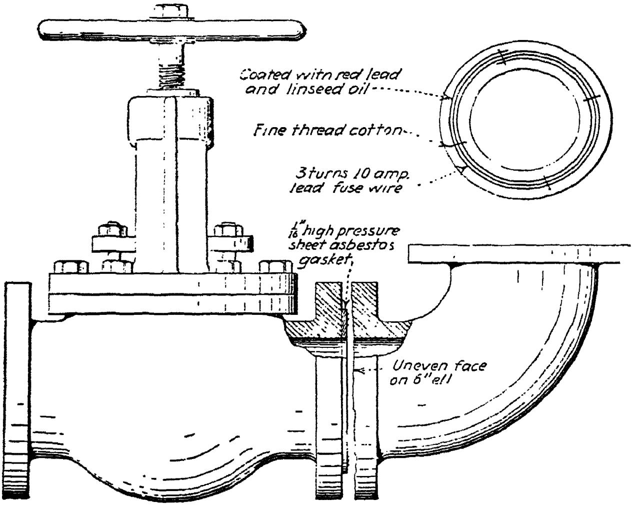

Coated with red lead and linseed oil
Fine thread cotton
3 turns 10 amp. lead fuse wire
1/16" high pressure sheet asbestos gasket
Uneven face on 6" ell

FIG. 241.—Sheet asbestos gasket reinforced with three turns of lead wire.*

Having tried several gaskets, none of which made a tight joint, I found the elbow face had not been faced off true. A regular high-pressure sheet-asbestos gasket 1/16 in. thick was prepared as follows: Three turns of 10-amp. lead fuse wire were laid on one side and held down near the outer edge with find thread (cotton) at about four points as shown. The side with the fuse wire was painted with a mixture of red lead and linseed oil; then the gasket was suspended and inserted between the flanges with the fuse wire toward the face of the ell. The joint was pulled up in the usual manner, and a small amount of steam turned on for about 15 min., allowing the job to get thoroughly heated without much pressure.

This job has now been in service for about a year, carrying 190 lb. pressure with about 100° superheat, and has remained perfectly tight.

Westmont, N. J. R. J. Nagle.

780. Improvised Light-duty Strainer.

The usual power-plant scrap pile plus a little imagination or ingenuity will frequently help greatly in time of need. One result of such a combination is the light-duty strainer illustrated, that I made some time ago for placing in air, water, and oil lines.

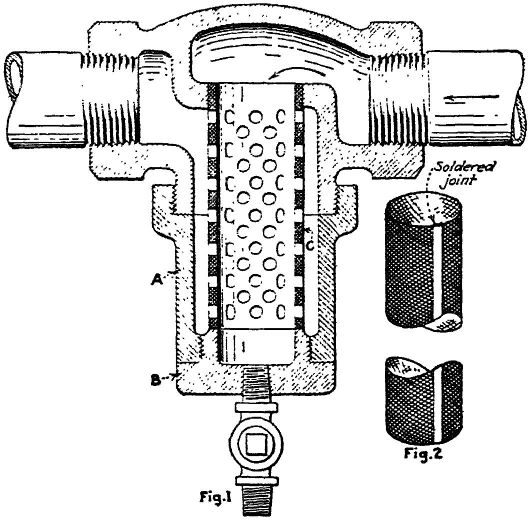


Fig. 242.—Strainer made from discarded globe valve.

Its principal part is the body of a discarded globe valve (Fig. 242). The additional parts *A* and *B* are made of brass and provided with a cleanout cock as shown. A fine-mesh strainer (Fig. 242-2) with a soldered joint is made a neat fit inside the strainer casing.

Long Beach, Calif. E. J. Jordon.

781. Handy Valve-packing Tool.

A handy packing tool for quickly placing packing around valve stems is shown in Fig. 243. It is made from a short piece of steel tubing of a suitable size to enter the stuffing box and slip easily over the stem. An opening is made in one side of the tube through which the packing passes as the tool is rotated. In use, the end of the packing is started in the usual way, and the tool is used to force the packing down until the stuffing box is filled. This is a rapid and time-saving tool.

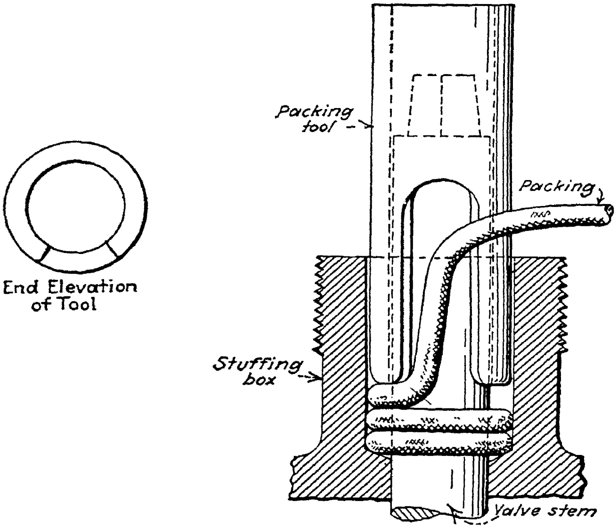


FIG. 243.—Tool in position for placing packing in stuffing box.

Syracuse, N. Y. H. L. WHEELER.

782-784. Valve-stem Troubles and Three Ways to Overcome Them.

782. When I find that a valve has become seized at the stem, I first try to free it by working it with a bar (commonly termed a persuader) attached to the wheel, as indicated in Fig. 244, being careful not to twist it so severely as to distort the thread pitch or otherwise damage the stem. If the stem cannot be moved with the persuader, then the threads are cleaned and soaked with kerosene, the yoke is heated to expand it, and the persuader is again tried, working the stem in and out a little and cleaning it at each move.

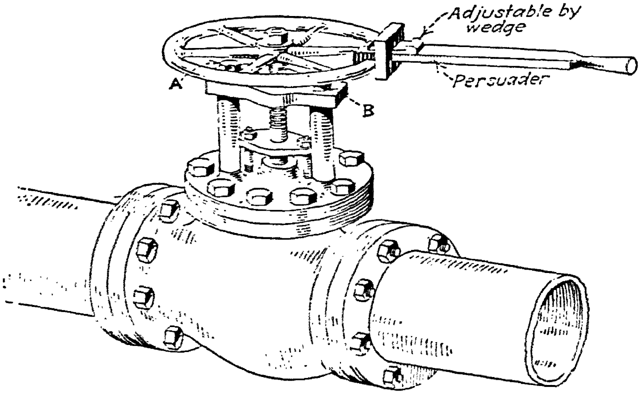


FIG. 244.—Use of collar and wedge makes "persuader" adaptable to several sizes of valve wheels.

783. Failing to give results in this manner, the valve is taken apart and removed to the shop for freeing. In the shop, it is bolted to a suitable angle plate, and a wrench put on the stem just under the head, or bonnet, flange, the persuader is applied to the wheel, and another attempt made to free it with the double leverage. If this attempt fails, the stem has to be cut off and drilled out, and a new one made.

784. When valves are closed under normal pressure and temperature, and the line is permitted to cool down, it is frequently found upon attempting to open the valve again that it is stuck tight. Slacking off the yoke-stud nuts *A* and *B* will relieve this strain. The valve will then move easily, the nuts on the yoke being tightened when the disk is free from the seat.

Concord, N. H. C. H. WILLEY.

785. Proper Line Connection for Pilot Valve.

When the source of supply for a pilot valve is taken from a point above the motor or mechanism which operates the valve, no trouble should ever be experienced, but when it is taken from below, the line has to be correct.

In my own case, I always connect the valve as shown in Fig. 245 and have never had a failure.

New York, N. Y. C. W. PETERS.

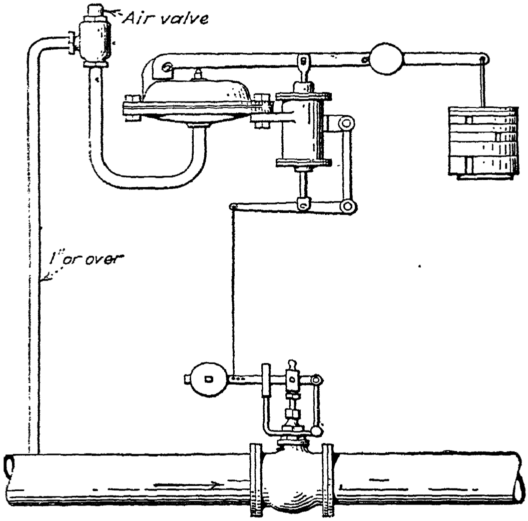


FIG. 245.—Connection for pilot valve above steam line.

786. Lead Pencil Is Excellent Detector for Leaky Valve Seats.

The ordinary lead pencil is an excellent detector, if not so good as the best, in makeshift means of determining leaky valve seats and running down mysterious pounds.

The unsharpened end of the pencil (no rubber end) should be held snugly but not too firmly in the ear. Rest the lead or point on the part under test. The lead center is an excellent conductor of the least bit of sound and is a simple but efficient means of running down many of those puzzling noises that indicate trouble.

Missouri Valley, Iowa. F. BENJAMIN.

787. Operating Overhead Valves from the Floor.

In most plants, there are certain small valves that must be opened or closed frequently, or the opening through the valve has to be changed many times during the course of a day. Frequently, these valves cannot be reached from the floor, and a ladder must be used. The method of extending the stem by means of a long rod with a forked end to fit into the handwheel is quite common, but the stem of the valve cannot always be made to point downward or at an angle so that this method can be used.

Where valves are placed with the stem horizontal, a wooden sheave is bolted to the handwheel, and sash cord is wrapped around the sheave and extended to within reaching distance of the operating floor.

Chicago, Ill. B. MEYERS.

788. Limit for Setting Valve Opening.

We wished to arrange one of the gate valves with a rising stem so that it could be opened and closed a definite amount repeatedly. This problem was solved by making a fitting to go on top of the hand wheel and bridge the valve stem, as in Fig. 246. An adjusting screw and locknut in the top of the fitting allowed setting a limit on the valve opening.

Jeanette, Pa. EDWARD B. BLACK.

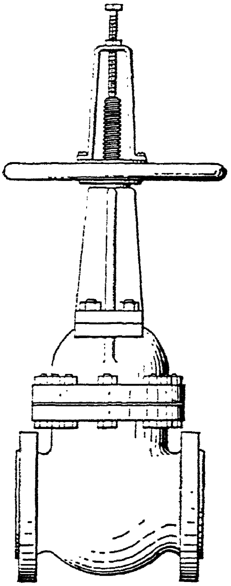


FIG. 246.—Adjusting screw at top of fitting limits valve opening.

789. Chain-operated By-pass Valve.

From the steam main in our engine room a 5-in. branch line carries steam to the emergency pump in the mine. This line is always kept under pressure and serves as a heating main with various branches attached. The pressure is kept at 10, 40, 80, or the full pressure of 140 lb. The main valve is shut except when operating the emergency pump.

When the main valve is shut, the pressure is regulated through a $\frac{3}{4}$-in. by-pass valve which is reached from a runway beside the steam main 10 ft. above the floor; and during the busy hours the valve often was neglected on account of its being so out of the way, the pressure occasionally going up to 40 when only 10 lb. was desired. At night, the pressure is cut down on the boilers to 60 lb., so the by-pass has to be regulated frequently. To simplify this work, we decided to provide some means of operating the by-pass from the floor. This was finally done as shown in Fig. 247.

Ironton, Minn. A. Lekstrom.

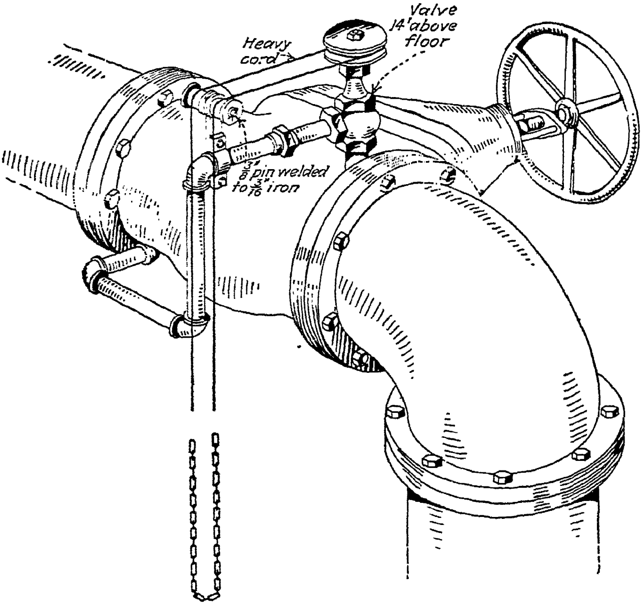


Fig. 247.—By-pass valve operated from floor by simple setup.

790. Remodeled Float Mounting Prevents Cracking.

Where floats are mounted on the end of the valve-control rod, as at left in Fig. 248, a heavy stress may be set up around the connection to the float, particularly if the float and valve are large. In our plant, we experienced considerable trouble from

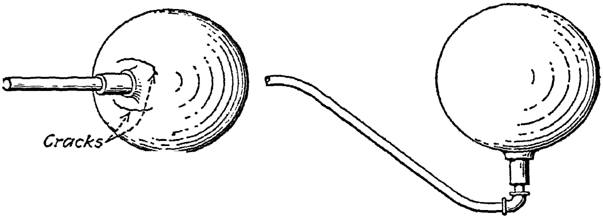


Fig. 248.—Left, old; right, new methods of mounting floats.

this cause with floats cracking around their connection. These floats were used to regulate the water level in large tanks. The trouble was overcome by connecting the floats to the valve-control rods, as shown at right. By lengthening and bending the valve rods to increase the travel of the floats, it was also possible to reduce stresses at their connections.

Cleveland, Ohio. S. R. STEVENS.

791. Lock Your Valves for Safety.

For valves within the plant that require some protection against tampering, I trust a locking strap attached to the body of the valve or to some structural part near by. I offer the method shown in Fig. 249 as one form of safe locking.

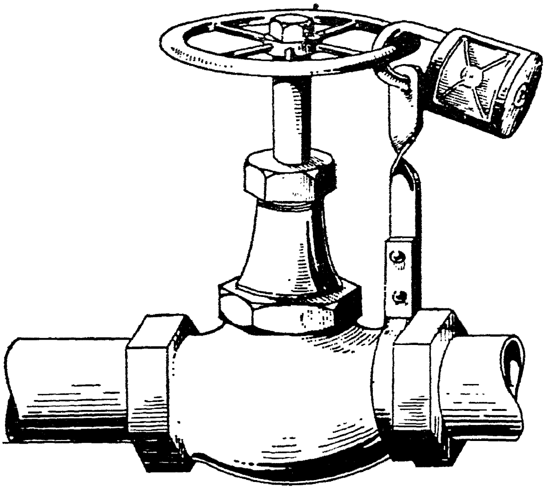


FIG. 249.—Simple locking arrangement for valves.

Penacook, N. H. CHARLES H. WILLEY.

792. Stopping Noise of Atmospheric Relief Valves.

The company installed several relief valves. Among them, two 12-in. valves were noisy and were exchanged for two others that proved to be as noisy as the first. Their operation was good, but when open, they rattled. As the valves were closed most of the time and were in the basement, they bothered little, but later, as other use for the exhaust steam was found, real noise began. Links, levers, and pins were bushed or renewed, but no matter how closely they fitted, they soon had plenty of room, and the noise was deafening.

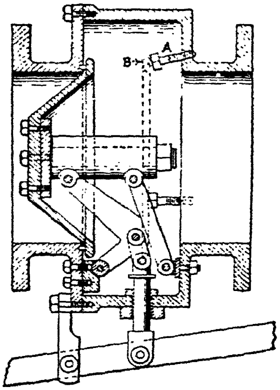


Fig. 250.—Section of relief valve, showing bolt locations.

The valves were taken out, and into each body, on the inside back of the disk, were screwed three bolts, shown at *A* in Fig. 250. These bolts were spaced 120 deg. apart, and the length and location were such that the disk opened to about the center of the space, with the back edge *B* of the disk, when open, resting against the bolts. The noise was entirely stopped.

Elgin, Ill.

W. L. Parker.

CHAPTER XIV

BUILDING SERVICES

Heating; Ventilating; Air Conditioning; Hot Water

793. Taking Care of Equipment during Erection.

To take care of additional radiation and to replace an obsolete heating plant, three 1,830-sq. ft. water-tube boilers and pumps were ordered by a certain company.

Erection took place during a severe winter. In unloading a section of tubes into the boiler house, a chain sling slipped, buckling a number of tubes in the center, which apparently was not noticed. The boiler setting froze as it was being erected, with the result that when a load of less than 100 per cent was being carried during the trial run, bad cracks showed up in the side walls. The chain grate ran backward owing to incorrect setting on first trial.

All pumps and large valves were allowed to lie around the boiler-house floor during erection, with consequent damage and bending of the spindles and stems. The tandem blowdown valve joints blew out while the boilers were being filled with water prior to lighting up. Safety valves did not lift at their tagged pressure; the steam-pressure gages did not correspond—one even had the pointer behind the zero stop. Automatic soot blowers were installed with their condensate drains so arranged that the operator was in serious danger of scalding. House and vacuum pumps spindles and bearings were covered with splashes of concrete.

Manufacturers evidently should demand that the utmost care be taken of their respective specialties prior to installation as a safeguard against the fineness of their products being wrecked by a few moments' careless handling by erectors.

Montreal, Que. E. O. Wilson.

794-797. Four Ways to Save Money in Heating Plants.

794. Boilers supplying low-pressure steam for building-space heating are offenders, with their daily operation under conditions unfavorable to economy throughout the greater part of the heating season. This stand-by loss is often not preventable with existing equipment and fluctuating demands, yet it may be minimized, and savings established with intelligent planning and foresight.

795. Many installations of heating boilers are much too large for the amount of steam they are to generate on an average; they are often proportioned, in a single unit, for a peak load that exists but a few days of a heating season. To keep the steam pressure within certain limits, the engineer is forced to run with banked fires the greater part of the heating season.

The most economical boiler installation for space heating results when boiler rating is considerably less than the maximum requirements.

796. Total boiler capacity required should be spread out into two or three units and on 150 per cent load basis, to provide flexibility during varying weather conditions without using banked fires with their attendant losses of heat.

797. If the boiler is already installed, alterations in the setting will be necessary to provide for air insulation that will intercept the heat radiating from a banked fire and transmit it to a location where it may be used to advantage. When this warm air may be used for building-space heating or any other heating and drying operation, it will be necessary to design a setting with a view to securing a balance between the supply and demand for warm air. For positive circulation installation, a fan and ducts will be necessary.

This warm air may be heated by contact with the boiler's external surface or by contact with brickwork that receives its heat from other brickwork in contact with the fire. The heat that is intercepted is mostly absorbed, and little is radiated from outside boiler walls, thus minimizing the major loss of a banked fire.

Brooklyn, N. Y. WILLIAM ANDERSON.

798. Utilizing a Vacuum System for Heat before Completion.

An unusual condition was encountered in furnishing temporary heat to a building at the Hudson River State Hospital, Poughkeepsie, N. Y.

A vacuum heating system being installed in the building was incomplete when heat was first required. Basement mains and returns and all radiator connections had been finished, so that low-pressure steam could be supplied to the radiators; but no vacuum pumps had been installed.

Heating-steam and return pipes ran from the hospital heating mains to the building through underground conduit. The conduit entered the building at a point higher than the basement returns.

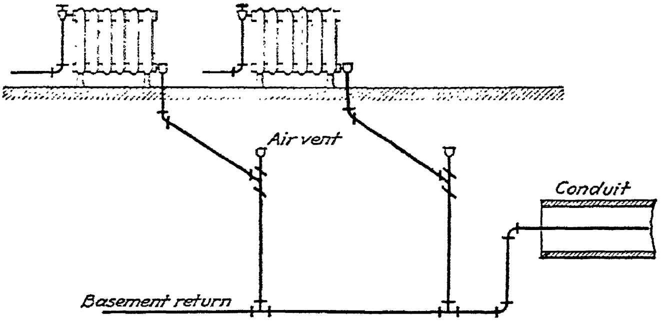


FIG. 251.—Radiator returns with air relief on each drop leg.

No floor drains had been provided in the building basement to permit of wasting condensation from the radiators.

The fact that the main return in the conduit was higher than the building basement return at first prevented establishing flow of the radiator condensation from the basement returns to the main return in the conduit. This difficulty was overcome by installing radiator traps at the top of each return drop leg which lead into the basement return pipes, as shown in Fig. 251. These traps expelled any air that collected in the building returns and prevented them from becoming airbound. The head of water in the pipes maintained a steady flow from the basement returns to the conduit return pipe.

Wassaic, N. Y. THERON W. BEAN.

799. Incorrect Radiator Piping Causes Water Hammer.

I took a position as engineer in one of New York's older hotels. The management told me that several guests had complained of a disagreeable water hammer in the radiators when they were turned on in the morning. I discovered that in these particular rooms, the branch line to the radiator is connected to the steam riser through two 45-deg. fittings and is pitched from the riser toward the radiator. As long as the valve at the radiator is open, steam condensed in the branch will drain to the radiator and out through the trap.

It is quite customary, however, for hotel guests to shut off their radiators at night, and when this is done, steam condensed in the branch is trapped between the radiator valve and the two 45-deg. fittings. In the morning, when the valve is opened, the trapped water surges against the valve and creates a most disagreeable water hammer. If the occupant becomes alarmed at the racket and closes the valve, the water will surge back and forth in this line, and the water hammer continue for a considerable time.

The remedy, of course, is to remove the trap in this branch line by pitching the line toward the riser.

New York, N. Y. P. R. BROCKNER.

800. Cooling Heating System Returns with Cast-iron Radiator.

Radiation exposed to blasts of cold air usually is operated with steam pressures above those ordinarily used. When the cold air strikes the radiation at a high velocity, there is a tendency for a vacuum to be formed due to the sudden condensing of the steam. This area of low pressure tends to hold a portion of the condensation in the radiator and makes complete drainage difficult without a vacuum return line, and when a vacuum return line is used the condensation is usually too hot for the pump to handle, thereby destroying the differential in pressure required for efficient operation.

Cooling-coil radiation is often used to remedy the condition and is usually installed at the foot of a return riser or across the return main. It provides additional space heating and at the same time decreases the temperature of the return to that corresponding to vacuum necessary, usually about 15 in.

To reduce the temperature of the returns with a minimum of cooling surface, all parts of the surface should be exposed to condensate and be active at all times. Ordinarily, cast-iron radiation is unsuited for this work, as it is possible that much of the surface will be by-passed, the condensation passing from inlet to outlet along the shortest path.

Figure 252 shows how an efficient cooling-coil radiator may be built from tubular cast-iron radiation to receive the condensation of an overhead unit heater. The dark space between sections denotes a solid right and left hexagon nipple, and the white space

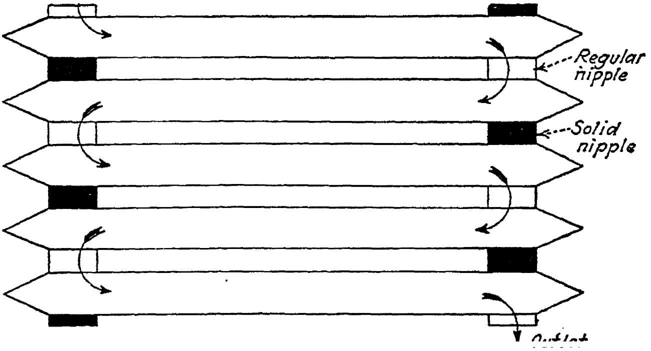


FIG. 252.—Cast-iron radiator arranged as cooling coil.

at the other end of section denotes a regular right and left hexagon nipple. The arrows show the flow of condensate from section to section.

Brooklyn, N. Y. WILLIAM ANDERSON.

801-804. Four Pointers on Using a Vacuum Pump on Air-line Heating System.

801. Instead of installing a steam-operated ejector for use with an air-line vacuum system of heating containing 25,000 sq. ft. of direct radiation, the engineer decided to put in a motor-driven reciprocating pump. The pump he selected was designed for dry-vacuum service, having brass suction and discharge valves and a piston fitted with cast-iron snap rings. Piston diameter was 4 in.; and stroke, 6 in. The crankshaft, running 100 r.p.m., was geared to a 1-hp. motor.

More or less water vapor worked through the air valves attached to the radiators and heating coils and condensed in the air line, requiring the pump to do wet-vacuum service. This interfered with lubrication of the metal-packed piston and compelled remodeling. Rubber valves were substituted, and the snap-ring piston was replaced by one fitted with fibrous packing.

802. The pump gave a displacement of about 0.35 cu. ft. per 1,000 sq. ft. of direct radiation. This rating insured efficient working of the plant, but it is not to be regarded as arbitrary for any system of the size under consideration.

803. To give the valves tight contact and to fill up the clearance spaces in a wet-vacuum pump, a water seal is necessary. The apparatus erected for that purpose in this instance is shown in Fig. 253. Stopcock *A* is opened just enough to let a small trickle of water pass through from the elevated reservoir into the suction line. This sealing water returns to the reservoir through the discharge pipe, and any extra water from condensation of vapor in the air line overflows into the sewer.

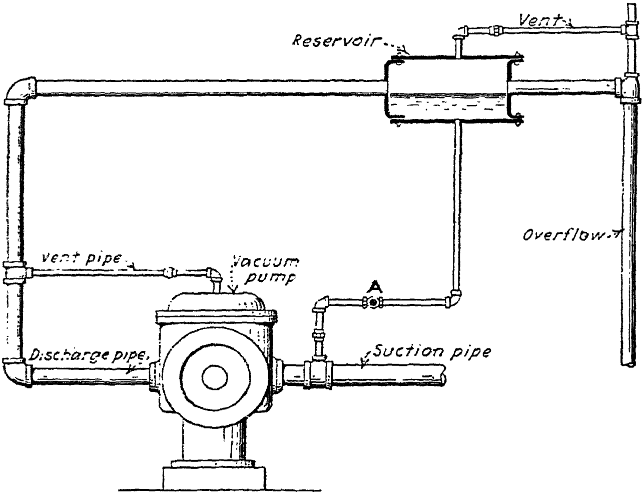


Fig. 253.—Water seal and vents for wet-vacuum pump.

804. The discharge as well as the suction connections, being on the side of the pump, instead of on the valve-chamber hood, makes for convenience in getting at the valves for inspection or renewal. This construction, however, invites air or water vapor to collect in the hood, thus diminishing pump capacity. In the present instance, the engineer avoided this difficulty by running a small vent pipe from the central point of the hood to the discharge pipe.

St. Louis, Mo. A. J. Dixon.

805. Repiping a Heating System to Separate Air from Condensate.

In the old-type Webster steam-heating system in Fig. 254, the vacuum pump handles the condensation and also the noncondensable gases, the latter being principally air that enters the system with the steam or around loose valve stems whenever the pressure within the system is less than that without. Special thermostatic valves control the discharge from the units of radiation into the return piping to the pump. Just before the pump is reached, a condenser is installed in the piping. In the top of the condenser is a raw-water jet used to condense the steam that gets past the thermo-valves and would interfere with the best working of the pump. The condenser also contains a strainer through which all the water must pass and which removes foreign matter that might injure the pump. The pump passes whatever it handles on toward the heater, and it is highly important to separate the air from the water before it reaches the heater. This separation is accomplished by the scheme of piping shown.

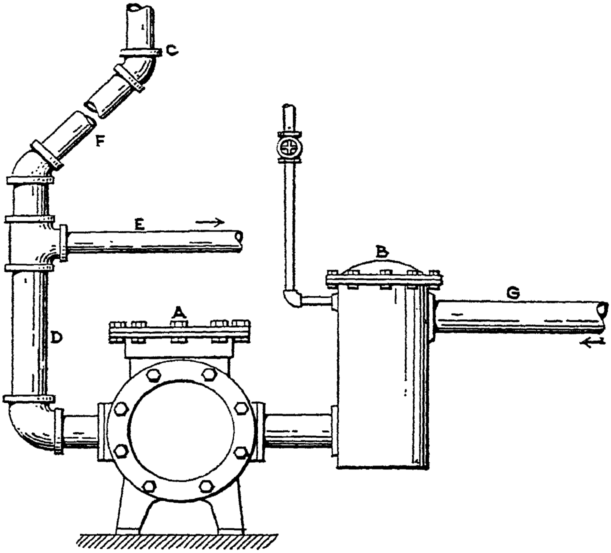


FIG. 254.—Inclined pipe separates air from condensation.

Referring to Fig. 254, we see that returns come back through pipe *G*, pass through condenser *B* and vacuum pump *A* and are discharged through pipe *D* to enter the heater through pipe *E* and rise in the inclined pipe separator *F* to the height *C*, equivalent to the pressure on the heater.

In this inclined pipe, the air bubbles rise to the upper wall, along which they move until they escape up the vertical pipe. The water passes down the lower wall of the pipe to the heater.

Peoria, Ill. P. W. LEWIS.

806. Raising an Air Line on Vacuum Heating System.

When steam connections for heating our new building were called for, we found a T in place in the tunnel, but the vacuum pipe ran squarely across the opening. This was taken care of as shown in Fig. 255, the dotted lines indicating where the pipe was found, and the full lines showing where we placed it.

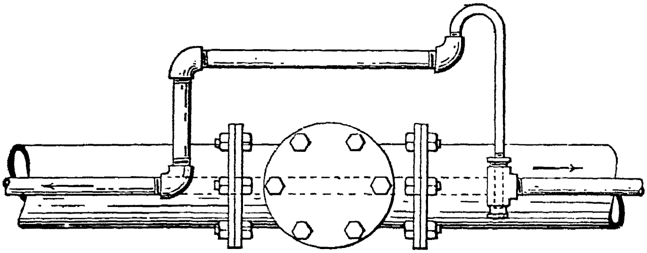


FIG. 255.—Change made in air line.

This method was used so that the pipe would be kept drained of water at all points. Considerable water is carried by the air lines, and wherever the water collects corrosion starts. The direction of flow of both steam and air lines are indicated by the arrows.

Elgin, Ill. W. L. PARKER.

807. Water Leg Protects Heating Main.

A hospital heated by exhaust steam from engines generating power supplied any deficiency by reducing 100-lb. steam through a reducing valve to 5, the average back pressure carried on the engines. Cast-iron radiators were used, making it necessary to protect them against excess pressure in the heating main.

A safety valve was not desired, if possible; therefore a water seal was installed on the heating main as in Fig. 256. The water leg was constructed for a possible head of about 16 ft. in the riser before the water would spill over and break the seal. This head allowed (16 × 0.434) about 7 lb. per square inch maximum pressure in the header. A small drain line was tapped off the lower end of the downcoming pipe line to prevent condensate from filling up to the steam main. This line was connected to a low-pressure trap line receiver, making the water leg also a drip pocket in the steam main.

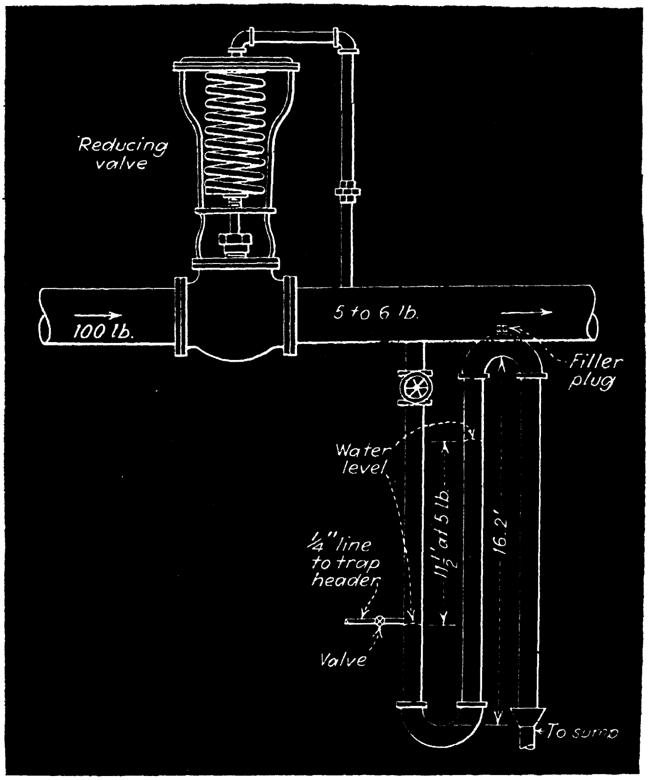


Fig. 256.—Water leg put in heating main.

If the pressure-regulating valve sticks open, as soon as the pressure builds up to 7 lb. the water seal will be forced, allowing free passage for steam to escape. A valve at the top of the downcoming pipe is locked open. A plug is installed at the top of the bend. Should the water leg be blown out, it can be reset by unlocking the valve, closing it, and refilling through the plug connection. The key to this valve is kept by the man in charge, who sees to it that the valve is open and locked before live steam is allowed to pass the radiators.

Boston, Mass. CHARLES A. ARMSTRONG.

808. Providing for Free Flow of Air in Heating Return Lines.

Where a return line from a heating system supported on a wall passes across a doorway or other obstruction where a clear passage is desired, a full-sized line for carrying the condensate is run under, and a smaller line to allow for the passage of the air is run over, as shown in Fig. 257.

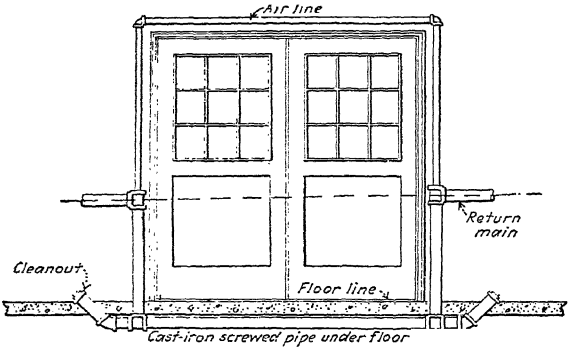


FIG. 257.—Changes in return line to pass obstruction.

If no air line were installed, the line under the doorway would obstruct the air by forming a water seal. This water could only be removed by a vacuum pump, with which all systems are not equipped, and would fill again as soon as the pump was idle. By keeping the discharge side the same level or lower, the entire system is drained free of water irrespective of any vacuum pump.

As this line catches all heavy particles carried along in the condensate, such as scale, it is necessary to provide cleanouts. Steel or wrought-iron pipe will not last long buried in the ground with damp earth in direct contact; cast-iron or brass pipe is better and will cost less than a trench and cover.

Remember to provide for expansion. This is taken care of by wrapping the pipe in building paper and air-cell covering where it passes through the floor slab.

Portland, Ore. JAY H. KELLER.

809. Handling Irregular Condensate Return.

Our heating load consists of school buildings equipped with direct radiation and mechanical ventilating systems, and, as the latter are operated only part of the time, condensation return is sometimes much in excess of feed-water requirements. Installation of a surge tank was considered but was found impracticable, as some of the vacuum pumps could not develop sufficient pressure to raise the water to an elevated tank.

A float box was installed alongside of the heater, just below the overflow level, making connections between the top and bottom of the heater and the float box so that the water levels would be the same. The float box contains a float valve arranged to open when the water level rises and close when it falls. A hydraulically operated valve is installed on a branch of the condensation-return line so that when the valve is open part of the condensate is free to flow to a storage tank at a level lower than the heater. Water at a constant pressure is supplied through a needle valve to the float valve and the cylinder of the hydraulically operated valve, the needle valve being choked so that when the float valve is open there will be insufficient pressure to close the hydraulically operated valve and allow part of the condensate to run directly to the storage tank.

Altoona, Pa. A. R. MARKLAND.

810. Maintaining Water Level in Receiving Tank.

In our condensation receiving tank, the float controlling the make-up water valve required so much attention that we devised the control apparatus, shown in the figure, to relieve the trouble. This consists of a copper bucket *H* (Fig. 258) hung where it will always be kept full of water, a small disk with two grooves in its face bolted to the handwheel of the make-up water valve *K*, the pulley *L*, and the counterweight *J*. A chain leading from balance weight passes over the pulley down to and around disk *K* and is attached to one of the grooves. The chain attached to the bucket passes around the other groove and is likewise attached to it.

When water level in the receiving tank lowers, the bucket drops with it, opens the valve to admit more water into the tank, and raises the counterweight. As the water level in the tank rises, weight *J*, which is about one-half that of the bucket filled with water, raises the bucket and closes the valve, thus admitting less water into the tank until the valve is fully closed.

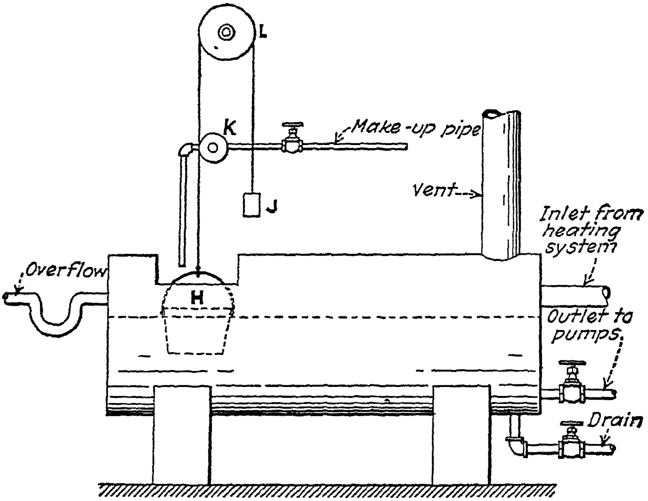


FIG. 258.—Method of controlling make-up water valve.

Elgin, Ill. W. L. PARKER.

811. Condensate from Heating Mains Used as Sealing Water on Turbine Glands.

Our heating-system mains are active owing to steam's being used the year round. There is always quite a flow back of condensate. This was considered a source of suitable water but too hot for turbine gland use. Some time before, there had been a leak in a nest of coils in our ammonia condenser, and the nest had been replaced. So we hit upon the idea of installing one of the removed coils vertically in the cold well of the turbine condenser to cool the condensate. The condensate was piped to tank *A*, through float valve *B*, as in Fig. 259. The tank was connected to one end of the vertical coil in the cold well, and a centrifugal pump to the other end, which delivered the water to the glands of the turbines. The water, in passing through the coil, was cooled sufficiently for gland use. Raw water was also connected to the tank for emergency use.

Elgin, Ill. W. L. PARKER.

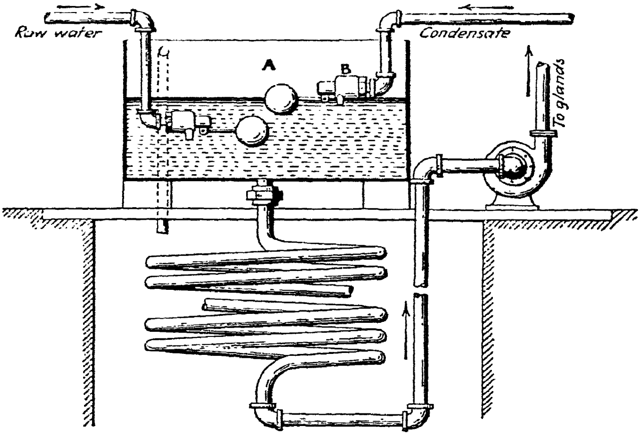


FIG. 259.—Condensate from heating main used for turbine-gland water by cooling in cold well of condenser.

812. Condensate Receiver Made from Discarded Boiler Drum.

Return-tabular boilers or drums of water-tube boilers that have been discarded make excellent receivers and oil separators for condensate returns. Figure 260 shows what was done in one case.

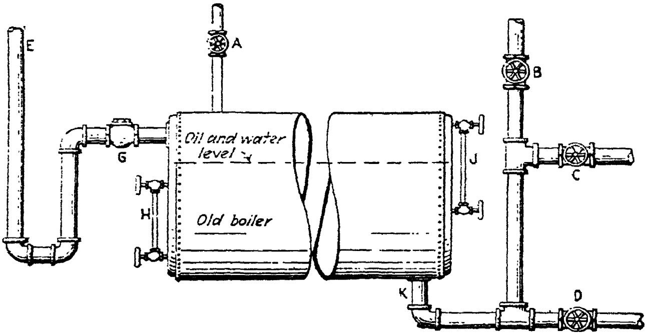


FIG. 260.—Discarded boiler drum becomes condensate receiver.

Connection *A* is for steam or air pressure, as most convenient, *B* is the suction to a steam pump, *C* is an overflow, and *D* is a supply for an injector. *E* is the drip supply to the tank. Two gage glasses are used to indicate the high and low water level.

In operation, valves *A* and *C* are closed when *B* or *D* is in use to supply pump or injector. To blow out the tank, *C* is opened, and *B* and *D* closed, and then valve *A* is opened.

Toronto, Ont. J. E. Noble.

813. Altered Drainage Connection Removes Cause of Water Hammer.

Owing to the crowded condition of the power-plant apparatus in the basement of a factory building, it was necessary to put a downward offset in the main supply line of the ordinary one-pipe heating system in use. Running up from the depressed section of the line were two risers which carried the steam to about half the radiators in the building. Eventually, a loud and persistent water hammer would begin shortly after the steam was turned on in the morning. One day, a visiting engineer suggested that the 1-in. drain pipe, shown in full lines (Fig. 261), might be stopped up at its point of connection with the receiving tank.

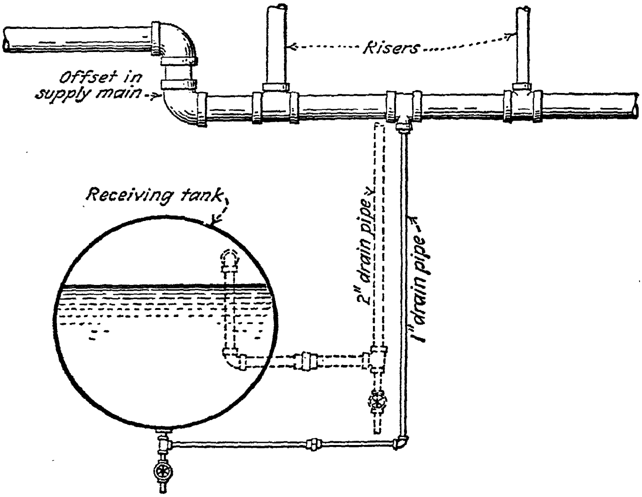


Fig. 261.—Original and improved drain connection to receiver.

And so it was. All of the water for feeding the boilers was first delivered to the receiving tank. As the source of supply was impure, much sediment had accumulated in the bottom of the tank, choking the drain inlet and holding the condensation in the supply main and first-floor radiators—hence the water-hammer, also the necessity of carrying an excessive back pressure on the engines, often as much as 10 lb., to force any steam at all through the pipes.

The defect was corrected by running a larger drain from the offset section of the main pipe and connecting it to the receiving tank above the water level, as shown by the dotted lines in Fig. 261. Now there is no chance for the inlet to become plugged with mud and grease. With the altered arrangement, a back pressure of less than 1 lb. is sufficient to send the steam circulating whenever it is needed.

St. Louis, Mo. A. J. DIXON.

814. Altered Drainage Connection.

Usually, the condensation return from a low-pressure heating system has a check valve on it. Then, if pressure rises in the tank or a vacuum forms in the heating return on live steam main to which drip is connected, there will be no danger of water from the tank flowing into the lines.

When a check valve is used, however, the high water level of the tank should be at least 2 ft. below the steam main. If the pressure in the supply main becomes the same as the pressure in the return, the 2-ft. column of water will give the additional pressure necessary to lift the check-valve disk off its seat and allow condensation to enter the tank.

Toronto, Ont. JAMES E. NOBLE.

815. Protecting Heating Boilers from Pitting and Corrosion.

We are operating two low-pressure h.r.t. boilers, of 2,000 sq. ft. heating surface. We have prevented pitting and corrosion entirely by a system of electrolytic protection which attracts all metal-destroying properties in the water to a soft steel plate ½ in. thick, 12 in. wide, and 8 ft. long. The plate is suspended 3 in. above the top row of tubes and is insulated from the main shell of the boiler, as shown in Fig. 262-1.

This plate is connected to the positive side of a 10-volt, 10-amp., motor-driven dynamo, the boiler being connected to the negative side of the line. In addition to the two boilers, we operate two hot-water generators and one rubbish burner, each of which is fitted with a plate and connected to the system. Each plate has 2 amp. at 10 volts going through it 24 hr. a day during the entire heating season. A plate will last about two seasons.

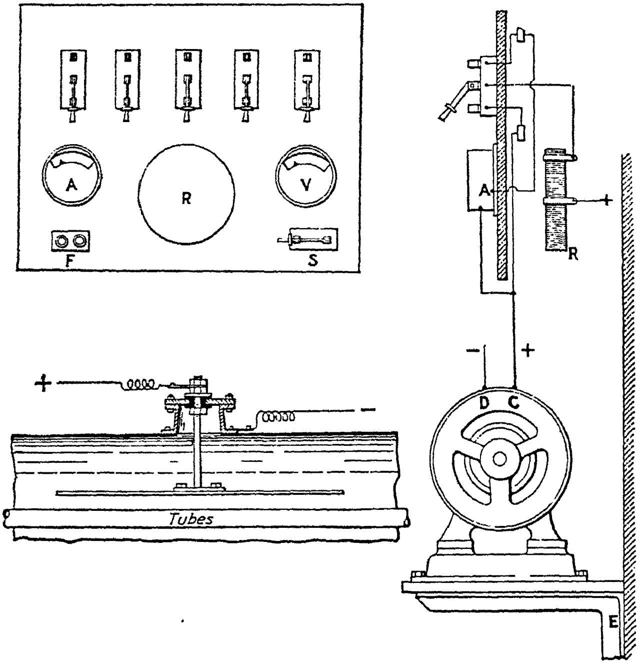


Fig. 262.—Left, how plate is suspended in boiler; right, connections.

The general arrangement is shown in Fig. 262-2. Each of the double-throw switches connects to one unit. The resistance shown at the back of the board is a 10-ohm tube. By throwing the switch into the upper contact, the current flows through the ammeter and, by moving the band up or down, gives the rate of flow desired.

Philadelphia, Pa. S. H. Nagle,
Plant Engineer, Packard, Inc.

816. Cast-iron Base Fails on Heating Boiler.

An unusual accident occurred to a heating boiler near the water-front. This boiler was of the cast-sectional type for low pressure.

Several times each year, when there was an exceptionally high tide, salt water would flood the basement. The water often reached a depth of several inches.

The boiler had been in operation many years, and careful attention had been given to its pressure retaining sections. The cast-iron frame around the ashpit which supported the weight of the boiler was not looked at very closely. One day when the fireman was beside this boiler, the base gave way. The boiler tipped over, severely scalding him. The corrosive effect of salt water and wet ashes had gradually wasted away the base.

Cleveland, Ohio. M. E. WAGNER.

817. Ejector Saves Coal on Heating System.

A heating system that had formerly run on about 5-lb. gage pressure was changed to operate on a vacuum by use of a water-operated ejector. All air valves on radiators were removed, and 1/8-in. air vents run to the boiler room and tapped into a 1¼-in. header connected to the suction of an ejector.

City water pressure at 60 lb. was used to operate the ejector, which produced a vacuum of 8 in. Hg. Packing glands on radiator valves were the greatest sources of air leakage. Careful repacking removed the trouble. The ejector was operated twice a day for about 20 min. and allowed heating to be done on 1 to 2 lb. gage pressure, the owners reporting a coal saving of about 15 per cent.

In some localities, it might not be advisable to use water to operate the ejector. Compressed air was used in another heating plant with very good results. When the ejector is not in operation the valve on the air-pressure line must be tightly closed to avoid air leakage back into the heating system.

York, Pa. J. S. CARPENTER.

818-820. Three Aids in Reducing Heating Costs.

A considerable saving and improved heating service resulted from two simple changes in our heating system.

818. In one factory building, the rooms on the north side of the ground floor could be kept comfortable in cold weather only by putting steam on 6 hr. before the factory opened in the morning. All floors were heated by one steam line, which meant unnecessary heating in some parts of the building. As all changes had to be made without buying any material, the final solution was to heat all pipe-coil radiation with high-pressure steam, leaving the cast-iron radiators on the low-pressure line. As all reducing valves were in the boiler room, this called for short runs of piping. The low-pressure trap was removed from the end of the pipe coils, and the condensation carried to the high-pressure trap that drained the main line. By this procedure the heating time was reduced by 3 hr. a day, which eliminated the wasteful practice of heating the entire building several hours before tenants arrived.

819. In the office building, the north-side top floor was the cold spot, and to have this room at 70° by 8 A.M. often required turning steam on at midnight, especially on Monday morning. The top floor had exactly the same amount of radiation as the floor below, yet temperature would be 5 to 6° lower. As a result of overheating the lower floors, windows were opened frequently, and two radiators would be shut off most of the time. To obtain a more uniform temperature, these radiators were transferred to the top floor, and other radiation transferred from sections where it obviously was not needed. This five-story building was adjoined on the north by a four-story structure; hence the top floor received the wind effect and should have been equipped in the beginning with 50 per cent more radiation than the other floors.

820. We had 4,500 sq. ft. of direct-steam radiation in the north section controlled by one main valve. As we reduced radiation of the overheated rooms to some extent, the net increase in total radiation in this section was only 100 sq. ft. We figured the saving as follows:

Originally, steam was kept on 4,500 sq. ft. for 12 hr. a day. After the changes, steam was on 4,600 sq. ft. for 10 hr. a day, and $(4{,}500 \times 12) - (4{,}600 \times 10)$ is a difference of 8,000 sq. ft.-hr., equal to approximately 2,400 lb. of steam a day. An additional saving of 2,000 lb. of steam a day was estimated by eliminating 75° temperature on the lower floors, steam costing 55 cts. per 1,000 lb. with oil as fuel.

Springfield, Mass. A. F. SHEEHAN.

821-824. Ways of Getting Better Heating-system Results.

821. A plant heated both its own and neighboring buildings with both direct and indirect heating and both vacuum- and gravity-return systems. Owing to faulty radiator traps in the customers' buildings, the returns came back so hot that excessive use of cold-water spray was required to the vacuum pump, and steam escaped in a steady stream from the receiver vents.

822. To reduce the loss of steam through the vents, the temperature of the water in the receiver had to be reduced without the addition of cold raw water, although much raw water had in the past been used to cool the water to secure proper operation of the feed pump. The hot-water heater for building service had a 2-in. exhaust-steam inlet and the same size of outlet as far as the trap. Live steam being always needed in addition to the exhaust, we decided to pipe the 15-lb. condensate from the indirect coils and another hot return line to the hot-water heating coil. This cooled the condensate, eliminated the raw cooling water, and reduced the vent loss to that just necessary for proper air removal. No further trouble was experienced with steam binding of the feed pump.

823. Another source of trouble had been the peak load thrown on the boilers when the indirect coils were put suddenly into service, which was about 2 to 3 hr. a day in cold weather. We figured that if the coils were supplied with warmer air, steam consumption would be greatly reduced. But the cost of ducts for recirculating the air from the rooms served by these coils was beyond what we could spend. We finally cut a small opening through the brick wall connecting the discharge side of the fan with the inlet side and throttled the main cold-air inlet sufficiently to give an air temperature of about 90 instead of 20°, as had been usually the case. This increase in inlet-air temperature gave an increased outlet temperature, but only two-thirds the quantity went to the room that was being heated. Operation of the fan for slightly longer periods was, of course, required; but as the fuel bill dropped along with the boiler peak load, the results were satisfactory.

824. We moved the valves on several small return lines back as close to the bottom of the return riser as possible and kept them throttled down somewhat after the first 2 hr. of heating in the morning. This procedure reduced the temperature at the vacuum-pump section considerably.

Springfield, Mass. A. F. SHEEHAN.

825-826. Two Pointers on Economy in the Use of Heat.

825. Often, in industrial processes, large volumes of poisonous gases and offensive odors must be removed, and uncontaminated air substituted for the protection of the occupants. In such cases, recirculation of any of the air would always present an element of danger and should not be tolerated.

826. Cold outdoor air is desirable when the heat produced by people and lights is in excess of the amount required to offset transmission losses. When such a cooling problem is encountered, cold outdoor air in sufficient quantity is an excellent medium to reduce the heat gain produced.

Brooklyn, N. Y. WILLIAM ANDERSON.

827-828. Two Methods of Remote Control of Unit Heaters.

In the Atlanta, Ga., public schools, ventilating and heating units are installed in each room. It was desired to start or to stop each unit by individual push button or to start them all at once by pressing a master push-button station. All motors were to be stopped simultaneously by opening a line switch at the power panel of the main switchboard.

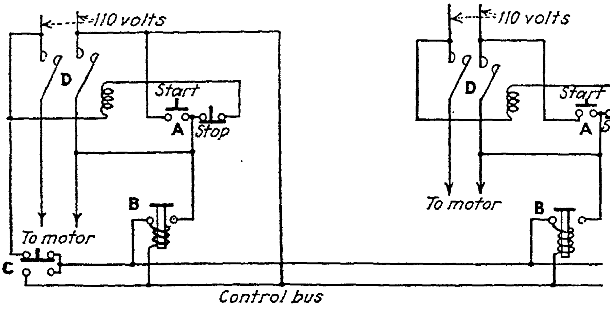


FIG. 263.—Connection diagram with relays held open by their coils.

827. With the arrangement (Fig. 263), relays *B* are normally energized, and their contacts are held open. The individual motors are started by closing push buttons *A*, which completes the circuit for the coil on contactor *D*.

Pushing button *C* down opens its top contacts and closes the bottom ones. This operation opens the *B* relay-coil circuits, and they close their contacts, which close the *D* contactor coils' circuits through the bottom contacts of button *C*. Completing these circuits will start all the motors as a unit. Any unit may be stopped without affecting the others.

828. In Fig. 263, the relay coils are across the line at all times except momentarily, when the motors are started. There will be about 2,000 of these relays with a power consumption of 4 watts each, which would amount to 8,000 watts. The relays have been modified, as in Fig. 264, by reversing the contacts, making them close the auxiliary circuits when voltage is applied, instead of opening it, as in Fig. 263. This arrangement eliminates the power consumption required to hold the relay open, as in Fig. 263. In Fig. 264, the relay coils are energized only for the brief interval that push button *C* is pressed.

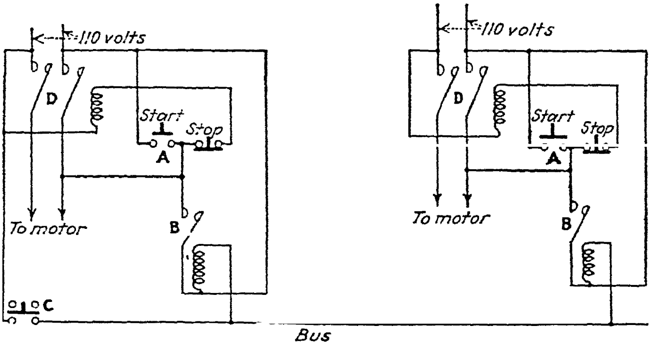


Fig. 264.—Connection diagram with relays normally open and closed by their coils.

Atlanta, Ga. A. M. Hill,
General Electric Co.

829. Recording Thermometer Used as a Back-pressure Valve Indicator.

The back-pressure valve on the exhaust line is usually located so far from the engine room, particularly in hotels and office buildings, that it is not known when the valve is open or closed. At the St. George Hotel, Brooklyn, N. Y., this difficulty has been overcome by installing a thermometer in the exhaust pipe just beyond the back-pressure valve. This thermometer is connected to a recorder in the chief engineer's office, where a record is made of the temperature outside the back-pressure valve.

In the heating season when all the exhaust steam is used, the back-pressure valve should remain closed at all times, and the thermometer give a minimum reading. On the other hand, in warm weather when heating load is light and there is an excess of exhaust steam, the back-pressure valve will remain open all the time. This will also be shown on the chart by a higher reading.

Brooklyn, N. Y. JOHN A. SETHER,
Chief Engineer, St. George Hotel.

830. Mercury Gage Indicates Pressure in Heating Main.

We installed a low-pressure mercury gage on the steam line to the heating system, but it was not satisfactory, because the line was much higher than the gage location. The difference in elevation caused the connection pipe to fill with condensate, causing a much higher reading than the actual pressure in the line.

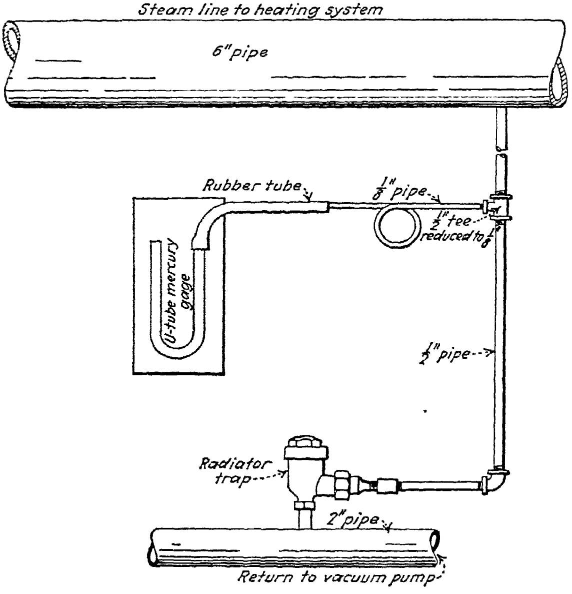


FIG. 265.—Mercury gage connected to condensate return.

The difficulty was overcome by connecting the gage to the vertical line leading from the steam header to the radiator trap on the return line to the vacuum pump. A loop was made in the pipe connection to the gage so that the head of water on the gage would remain practically constant, Fig. 265.

Westmont, N. J. GEORGE W. KNOWLES.

831. Relocation of Combustion Switch Cures Oil-burner Trouble.

Full-automatic operation of an oil burner on a heating boiler, after one year's service, caused considerable trouble. The safety switch would have to be manually reset one or more times daily, and automatic night operation was out of the question. The trouble was traced to a lag in the combustion-control switch in the stack. This switch was adjusted to the limit; then the heat element was removed and thoroughly cleaned but, when replaced, was not dependable. A new element was put in the switch, and this also was erratic.

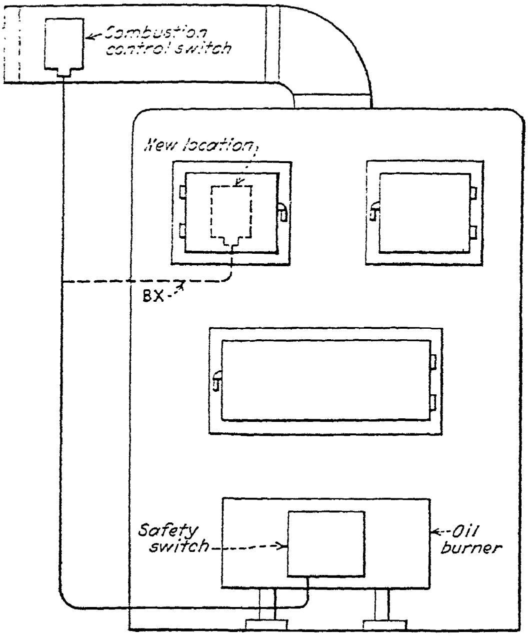


FIG. 266.—Combustion-control switch moved to boiler pass.

It was decided to put the combustion-control switch in one of the boiler passes, as indicated by dotted lines in Fig. 266, that it might be actuated more quickly. When this was done, the trouble was eliminated.

Brooklyn, N. Y. A. ANDERSON.

832. Simple Heating System Control.

Figure 267 shows an inexpensive automatic control of a heating system providing a maximum and a minimum flow of steam through the same valve, a three-way double-seated, double-disked diaphragm valve, one flow supplementing the other as called for by the room thermostat.

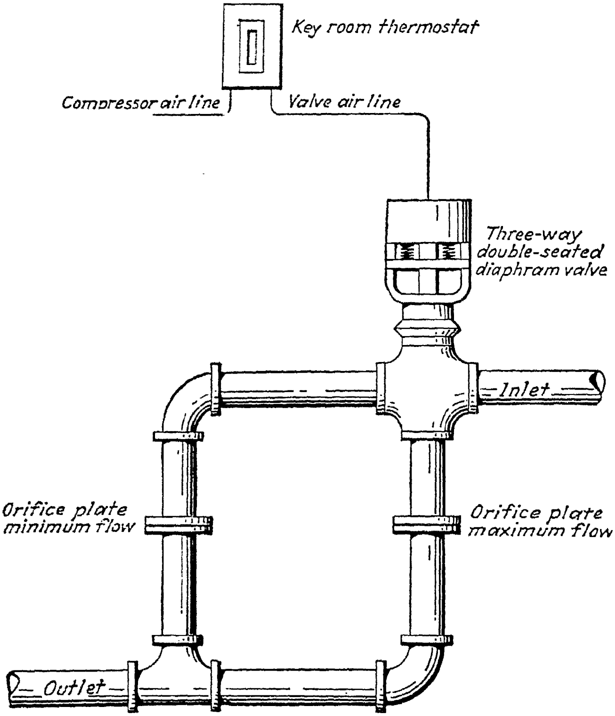

Key room thermostat
Compressor air line
Valve air line
Three-way double-seated diaphram valve
Inlet
Orifice plate minimum flow
Orifice plate maximum flow
Outlet

FIG. 267.—Piping for simple heating-system control.

The key-room thermostat, upon contracting and breaking contact, according to the room temperature, admits and relieves the diaphragm valve of air, which, in turn, seats the disk on one or the other seat for the maximum or minimum flow of steam.

Two orifice plates placed as shown meter the flow of steam and are inserted inside bolt holes of the pipe flanges.

With a fairly accurate layout, in cold weather the maximum flow is on most of the time, and in moderate weather the minimum flow is on most of the time if the plant conditions require it that way. The minimum flow may be taken as that required to assure perfect circulation in mild weather, or it may be the flow of steam normally used in the heating season, and during the mild weather the source of supply may be throttled, making the control semiautomatic.

Considerable economy may be effected by this means of control when a studied application is made of its tapering action, especially in a vacuum-return-line system.

Orifice plates should be inserted as shown, so that the maximum flow of steam will be available should the air supply fail.

Brooklyn, N. Y. WILLIAM ANDERSON.

833. Low Air-pressure Alarm for Temperature-control System.

A small air compressor is used automatically to maintain 15 lb. of air pressure on our system of temperature control, its range being between 14 and 16 lb. Occasionally, the compressor fails to start again after the pressure falls below 14 lb., with the result that all radiator valves in the building open wide, and the building becomes overheated in a few minutes.

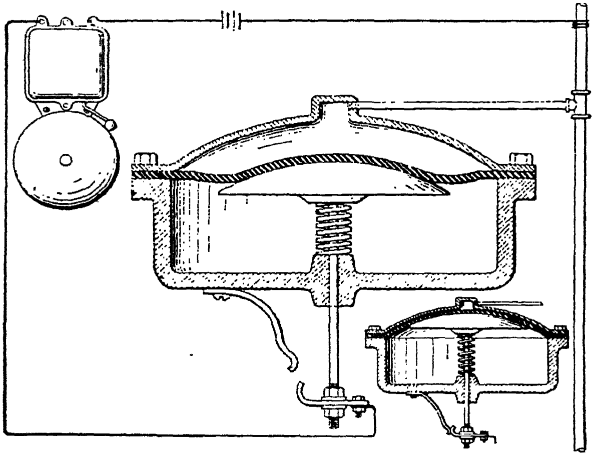


FIG. 268.—Diaphragm valve with contacts.

As the plant attendant or engineer has other duties to attend to, often he does not notice this condition before some one from the overheated rooms calls his attention to it.

To end this trouble, we made an alarm outfit from material around the plant, consisting of an old diaphragm valve, two dry batteries, and a bell. A T was put in the ⅛-in. air pipe, and the diaphragm valve connected (Fig. 268). From the batteries a wire was grounded to the air pipe, making a continuous circuit to the contact. From the other side of the battery a wire was run to the bell and from the bell to the movable contact, which was insulated from the valve rod by the two mica strips.

The larger view shows the diaphragm inflated and the circuit broken; and the smaller one, the diaphragm collapsed and the contact closed.

Duluth, Minn. NELS HILSEN.

834. Automatic Control Increases Heating-system Efficiency.

St. Paul's Church, in Salt Lake City, installed a new heating plant which uses oil as fuel. The method of heating is by indirect steam utilized in coils in a central duct system, warmed air being circulated by a motor-driven variable-speed fan. Operation of oil burners is controlled by a thermostat in one of the meeting rooms and set at 70°.

After the plant had been in operation for a short time, it was found that the main fan, which started up at the same time as the oil burner, delivered cool instead of warm air to the church rooms. This air continued cool until such times as the oil burner had caused enough steam to be generated in the boiler to heat the coils in the air duct. This was objectionable, and a remedy was found in the following arrangement:

A standard magnetic starting switch was installed to start the motor-driven fan and so arranged that the motor would start from any desired speed setting. The main thermostat in one of the meeting rooms was so connected that it would start the oil burner in the customary manner and at the same time actuate a time-delay relay, the contacts of which were used to close the magnetic switch for starting the fan motor. When the temperature in the main room drops to, say, 68° the thermostat makes contact and starts the fire under the boiler, and then the fan, depending upon the setting of the time-delay relay, starts up several minutes later, forcing air over the now heated steam coils. When the room reaches 70° the oil burner is automatically shut off, and the time-delay relay is again energized and at the end of 15 min. will shut down the fan. This overrunning of the fan after the fire is out recovers the stored heat in the steam coil and thereby increases the efficiency of the system.

Salt Lake City, Utah. E. BACHMAN,
General Electric Co.

835-850. Sixteen Points on Maintenance of Automatic Controls on Heating Boilers.

Automatic devices, such as water feeders or regulators, motor cutout switches, and gas cut-off valves, may be of value in preventing damage to heating boilers from low water if they are:

835. Tested at regular and frequent intervals—by blowing off the float chamber or lowering the water in the boiler, to see whether the device responds as intended. This should be done once or twice a week.

836. Properly maintained—by keeping clean, by frequently blowing off the float chamber during the heating season and opening the chambers for examination and cleaning once each year, at which time all moving parts should be carefully examined for deposits or corrosion which might cause them to stick; also by taking apart the water valves of feeders to note their condition. The best time to dismantle a device is just prior to the heating season, in order to detect damage that may have developed while equipment was idle.

837. Properly installed—by setting at the correct level and adjusting properly; by providing for blowing out and connecting with the proper pipes; all as specified by the manufacturer. For water feeders, brass feed pipes between the water-valve parts and the boilers are recommended; otherwise, scale is likely to deposit, particularly where pipes enter boilers.

838. Of adequate capacity (if the device is a water feeder)—so that it is capable of maintaining the water in the boiler at a normal level, while operating at maximum capacity, under normal conditions.

Reliable manufacturers recommend these precautions:

839. When contemplating installation of any device on a boiler not already provided with one, all the facts should be considered before undertaking the installation.

840. For boilers equipped with oil burners, a water feeder or a motor cut-off or both can be used. With the former, the boiler is protected by keeping the water up to a certain level. With the latter, the boiler is protected by having the fire cut off as long as the water in the boiler remains low. Either, if reliable, should be sufficient. It is customary to provide double protection by having one of each installed.

841. For gas-fired boilers, it is customary to provide a gas cut-off valve, and in some cases a water feeder is also installed. Either of these devices should be sufficient.

842. For coal-fired boilers, only water feeders need be used.

In my opinion, a water feeder for use on heating boilers should possess the following features (which represent a standard of comparison for rating feeders):

843. Feed water should not pass through the float chamber so that scale cannot be deposited there. (Credit, 20 points.)

844. The feed valve should be so separated from the float chamber, or the boiler, that the temperature cannot rise above the point at which scale will be deposited (212°). (Credit, 20 points.)

845. There should be as few bearings or stuffing boxes as possible in the float chamber. (Credit, 16 points.)

846. There should be as few bearings or stuffing boxes as possible in the feed-valve chamber. (Credit, 12 points.)

847. The water-valve parts should be of noncorrosive material to minimize sticking. (Credit, 12 points.)

848. There should be a generous-size and readily removable strainer to keep out gravel, sediment, and other foreign matter. (Credit, 8 points.)

849. The assembly should be such that the parts can be readily opened or taken apart for periodic examination and cleaning. (Credit, 8 points.)

850. The float should be large (at least 6 in.), and the leverage ratio high, to insure powerful operation of water valve. (Credit, 4 points.)

If a feeder possesses all of these points, it may be rated 100 per cent. In counting under features 845 and 846, a discount of 4 points for each bearing should be made. By this count, if there were four or more bearings, or stuffing boxes, in the float chamber or three or more in the water-valve chamber, all credit points would be wiped out.

The ratings given have been strikingly justified by failures occurring almost without exception on water feeders with a low rating.

New York, N. Y. A. J. Loppin,
Assistant Superintendent, Inspection Department,
Fidelity and Casualty Co. of New York.

851. Steam Requirements Shown by Signal System.

In many industrial plants using large quantities of heating steam, it is desirable that the boiler-plant operators have advance notice of large demands for steam. This can be done by a system of signal lights. Two fixtures, each containing three ordinary lamp sockets, were made up. Partitions were placed between the lamp sockets, and sections were closed by glass windows, one green, another red, and the third yellow.

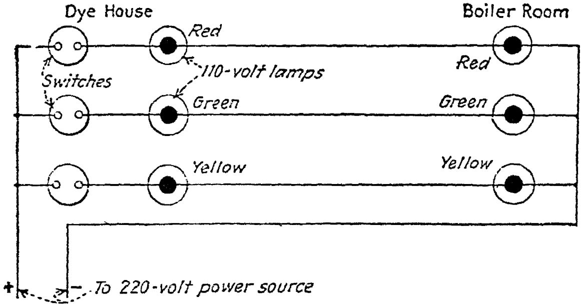


FIG. 269.—Signal system for steam requirements.

Ordinary white lights were used, and one fixture was placed in the boiler room and the other in the dyehouse in positions where they would be easily visible. Control of the light was provided by three snap switches. Lamps may be wired in series or parallel, but if wired in series, as in Fig. 269, any fault causing one lamp to fail will also prevent the other from lighting. If 220-volt power is available, two 110-volt lamps may be used in series. The switches were painted red, green, and yellow to correspond to the color of the lamps that they controlled. A code of signals was prepared in which a yellow light indicated caution, or stand-by; a green light, half load; a red light, full load; a red and a yellow light, morning signal indicating to prepare for load; a green and a yellow light, night signal, notifying the fireman to close down the plant.

Montevideo, Uruguay. E. KERR

852. Condensate from Heating System Used in Water Heater.

In a building where steam is purchased and the returns from the heating system are discharged to the sewer, it was decided to pass this water through the water heater for use and thus save on water. The dotted lines in Fig. 270 show the changes made in the piping and the tanks added to save the returns. Return water now goes to a receiving tank in the basement. From there it is pumped either directly into the heater or to a storage tank on the twenty-third floor.

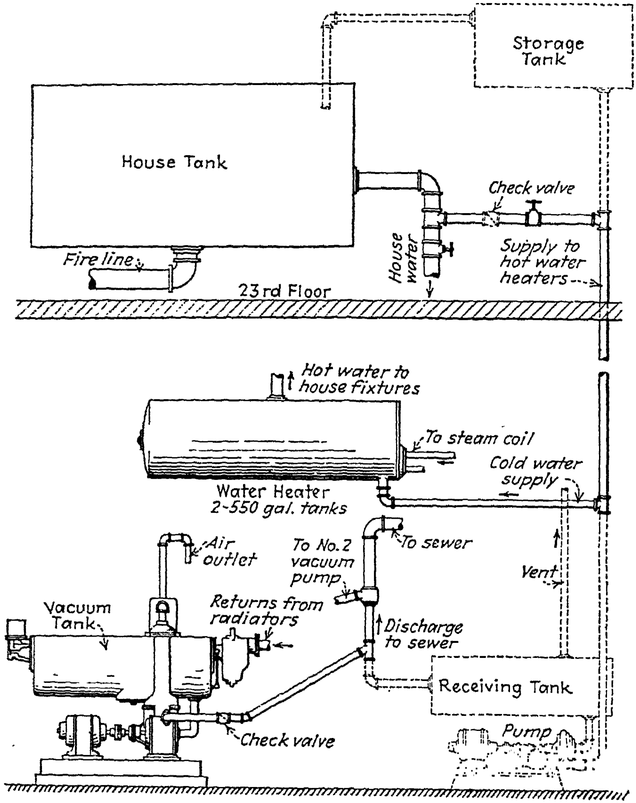


FIG. 270.—Condensate from heating system used to heat water.

In case there should be an excess of condensate from the heating system, which is not likely to occur, an overflow is provided from the storage tank into the house-service tank. Any water required in the heater above that supplied by the condensate comes from the house-service tank through the check valve between the condensate and house-water lines. The installation was simplified by using the cold-water supply pipe to the water heater for the supply line to the storage tank.

Nutley, N. J. THOMAS SHEEHAN.

853. Use of Live Steam for Hot-water Heating Reduced.

In order to save some of our excess exhaust steam that goes to waste during the fall and spring, we made the following improvement to the hot-water supply tank.

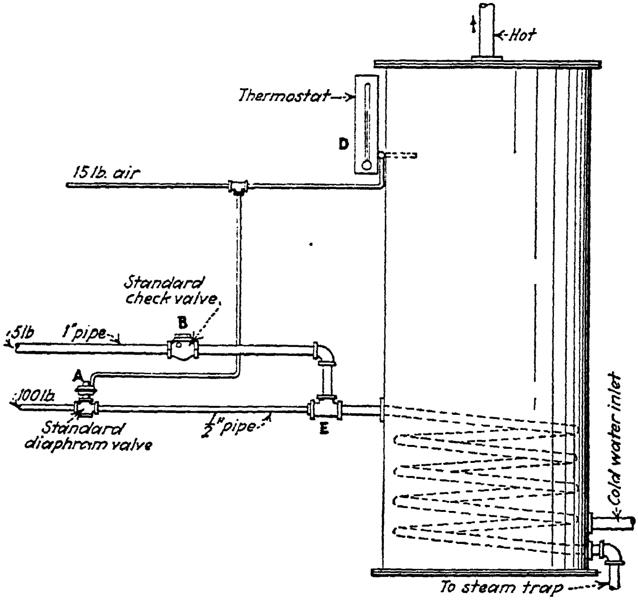


FIG. 271.—Connections permit use of both high- and low-pressure steam.

Previously, water had been heated only with steam at 100 lb. pressure. The large demand for hot water and the size of the coils made it impossible to use low-pressure steam only; but by arranging the piping as illustrated in Fig. 271, we were able to use some exhaust steam and to decrease the use of live steam.

We tapped the 10-in. low-pressure line and ran a 1¼-in. pipe to the tank, where we reduced it to 1 in. The ½-in. high-pressure steam line was cut at *E*, where we installed a ½- by 1- by 1-in. T. A check valve was placed at *C*, and the thermostatically controlled diaphragm valve was left at *A*.

When the temperature of the water rises to 180°F., thermostat *D* closes the diaphragm valve, thereby shutting off the high-pressure steam. This allows the check valve *B* to open and low-pressure steam to flow into the heating coil. The low-pressure steam keeps the water at 180° until a heavy demand for hot water lowers the temperature. The thermostat will then open the diaphragm valve, admitting high-pressure steam to the heating coils and automatically closing the check valve *B*.

Duluth, Minn. NELS HILSEN.

854. Faulty Water Circulation Improved.

Complaints were received from tenants that hot-water taps had to be held open and the water allowed to run for several minutes before it flowed hot. Poor circulation appeared to be the trouble, so the best way of correcting the trouble seemed to be installation of a small circulating pump. However, the budget did not permit this expenditure, and some other means had to be

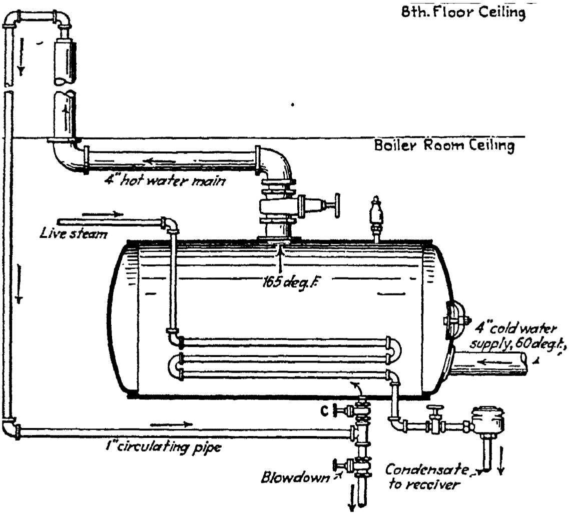


FIG. 272.—General arrangement of water-heating system.

devised. We decided to put a blowdown valve in the gravity circulation pipe, so that a circulation could be set up in this pipe any time by opening the blowdown valve. Then, each morning before the tenants arrived, the circulating pipe was blown down, after first closing valve *C*, until the water discharged felt warm. With this arrangement (Fig. 272) water consumption was materially reduced.

Toronto, Ont. LESLIE W. ROSS.

855. Emergency-tank Repair Proves Permanent.

Pitting in the hot-water heaters of the plant that I am operating unexpectedly culminated in the shell bottoms' "rusting through" in several places all about the same time. These heaters are of ⅜-in. steel cylindrical shell, 42 in. in diameter by 14 ft. long, set horizontally on cast-iron saddles supported by concrete piers. After the removal of a thin rusty coating from the inside of the shell, inspection showed 50 or more concave "pits," all in the lower segments of the heaters and ranging in diameter from 2 to 4 in. and in depth from ⅛ in. to clear through the plate at center of pitting. Portions of the shell in contact with the saddle supports were less affected than the rest of the shell.

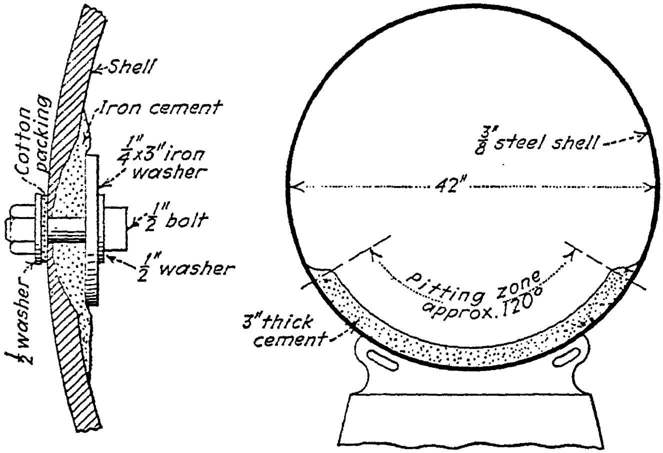


FIG. 273.—How the heater was repaired with iron cement.

The "through" or nearly through pits were drilled, and ½-in. bolts inserted, each having a ¼- by 3-in. plate washer under the head on the inside of the tank pulling down on to a convex mass of iron cement (Smooth-on) which had previously been puddled into and around the cavity, with nut, washer, and string grommet on outside of tank. The interior of the heater had, of course, been cleaned down to the bare metal and thoroughly washed out and dried (Fig. 273).

After the iron cement had set, 12 hr. being allowed, the inside of the heater shell was painted with two heavy coats of a nitrobituminous acid- and alkaliproof paint, the first coat being somewhat thinner to facilitate thorough penetration and to save drying time.

The paint was given 24 hr. in which to dry, and as an added precaution the patched segment of shell was covered with about 3 in. of portland cement, mixed one of cement to two of sharp, clean white sand. The cement was applied "dry tamp," and its surface smoothed or floated down to as fine a finish as a smooth bottle would give and allowed 4 hr. to set.

Precautions were taken to correct the conditions causing or permitting the corrosion, one of which was to install a temperature control that automatically maintains the hot water at within 5° of the normal temperature (165°). Frequent inspections during the four years since this job was done show that the cement "bottom" is still smooth, unbroken, unchecked, and tightly adhering to the shell; hence further repaired or replacement of the heaters is considered unnecessary.

St. Paul, Minn. W. Spofforth,
Chief Engineer, Ancker Hospital.

856. Water Lines Easily Traced with Aniline Dye.

Uranine, an aniline dye, has been employed in following the sources of subterranean waters. It has been used successfully by me as an aid in tracing pipe lines in the plant yards where water from different sources was in use. Perhaps there are many power men to whom a dye of this nature could be of valuable service, particularly as it is inexpensive and easily obtained from almost any dyehouse.

One-half ounce of this dye is sufficient to color 10,000 gal. of water an easily visible yellowish green with a decided green fluorescence, while solutions as dilute as 1 part in 100,000,000 show unmistakable coloring when compared with standard water solutions.

The quantities of coloring matter are so small that injury to boilers or other machinery requiring the water is impossible.

Arlington, N. J. RAYMOND L. DREW.

857. Sweating of Piping and Buildings in Cold Weather.

The accompanying curves (Fig. 274) show the limits of relative humidity for several types of structures or, rather, the conditions at which condensation will appear for various atmospheric conditions. In this curve, it is assumed that room temperature is maintained at 70°F.

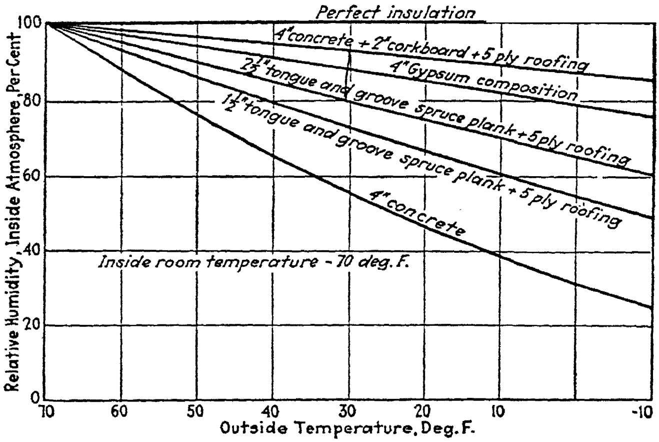


FIG. 274.—Points at which condensation will appear for various atmospheric conditions.

Condensation will occur at points above the curves for each given wall or roof. If the structure is made up of a combination of materials, condensation may occur between the layers, resulting in possible deterioration of the materials. Below the curves no condensation will occur. For example, for a 4-in. concrete wall, with an outside temperature of, say, 20°, relative humidity must not exceed 47 per cent for a 70° inside temperature. Otherwise there is danger of sweating. The properties of various atmospheres under different conditions of humidity, dew point, etc., can be obtained from standard reference books.

The essential items governing moisture conditions in buildings are:

1. Insulation of structure—the better the insulation the less likelihood of condensation.
2. Maintenance of minimum atmospheric humidity and lowest comfortable room temperature.
3. Good ventilation and air changes in room, with cold-air and cold-water sprays, if necessary, in generator circulating systems.

Pittsburgh, Pa. L. C. BREYER.

858-860. Three Pointers on Laying Up the Heating Plant for the Summer.

858. Attention should first be given to the boilers. The ash-pit, grate, and flues should be cleaned in order to prevent corrosion from sulphur contained in the refuse. Water should be drained from the boiler, and the water surfaces cleaned as much as possible. All water-column plugs should be removed, and pipes inspected.

859. Pumping equipment should be looked after next. All packing should be removed from the piston and valve-stem rods of steam-driven reciprocating pumps, as the old packing will tend to harden during the summer and, if used in the fall, may cause considerable wear on piston and valve-stem rods. Valves in the water end should be looked over and, if badly worn, should be renewed. Cylinder heads of pumps and engines should be taken off, and the cylinder smeared with oil. By working the piston back and forth several times, the piston will also be oiled. If no repair work is necessary, put the cover back on and draw up tight to be ready for next season. The engine slide valve should be taken out, the valve slide oiled, and the valve should be oiled and put back in place. All polished parts should be swabbed with cylinder oil.

860. All steam and oil traps should be taken apart, cleaned, and examined to see whether they are in good working condition. These traps are likely to leak more or less without the engineer's knowledge, and this affords a good opportunity to find out and correct it. Pressure-reducing valves should be taken apart, the water in the dashpots removed, and the piston, or plunger, and cylinders oiled. Where belt drives are used, the belts should be taken off the pulleys and put away.

Duluth, Minn. NELS HILSEN.

CHAPTER XV

REFRIGERATION

861. Operating Experiences with Ammonia Compressors.

Our slow-speed, horizontal, double-acting ammonia compressor developed a sharp metallic knock when the crank passed the outer dead center. The knock was most severe when starting up in the morning. Compressor clearance was checked, and bearings properly adjusted. After the bearings were adjusted, the knock did not quiet down but seemed to increase in sharpness.

During the run one day, the noise seemed to increase, and the watch engineer, after shutting down the machine, removed the discharge valve and cage (which on this machine are located on top of the cylinder at the end) and discovered a mass of metal on the bottom half of the cylinder flattened against the head. By means of long, thin chisels and scoops, the substance was removed through the cage opening without dismantling the compressor. It proved to be soft metal, about ½ lb. in weight, that had sluffed off the babbitt bushing and from the metallic rod packing. Falling into the cylinder bit by bit, it had been hammered into a solid mass the thickness of the clearance space by the movement of the piston in the cylinder.

The noise was greatest when starting up because the rod was then cold. The rod expanded enough when under running heat to keep the piston from hitting the deposited metal at the head.

In another case, a small, two-cylinder, vertical, medium-speed ammonia compressor, motor-driven through a belt, had too great a capacity for the load, so the motor pulley was changed, and the machine run at two-thirds its rated speed. Shortly after this change, the wrist pin of the trunk-type piston froze to the rod bushing, and the pin working in the piston started such a squeal that the machine was quickly shut down. Although caused by lack of lubrication, the reason for this could not be determined at the time. Oil level checked correctly, and the wrist-pin oiling device was in good order.

The wrist-pin oiler consists of a small ball check, spring loaded, that is attached to the bottom of the crankpin bearing. Dipping into the crankcase oil at every revolution, it pumps oil up a small tube fastened alongside of the piston rod. The tube curves over the top of the rod, and the oil drops into a small reservoir that drains to the wrist-pin oil groove.

A new pin and bushing were installed. After starting, the same trouble developed. This time it was discovered that the oil tube was clamped so as to restrict the opening between the tube end and the reservoir bottom to such an extent that the oil would not flow into it under the reduced pressure in the tube caused by slowing up the machine. Cutting a notch in the tube, thus allowing a larger escape area for the oil, remedied the trouble.

San Francisco, Calif. RAY B. WOLF.

862. Ammonia Compressor Knocks.

It has been my experience that in a number of cases where the knock appeared to be in the crosshead of a horizontal ammonia compressor the source of the trouble was a loose piston. In that case, the piston may be examined through the valve ports, with the valves on the head end removed. A usual method of determining if the piston is loose is to hold a thumb and finger on the nut and the piston, while a helper gives the piston a solid jar by means of a heavy bar through the other valve port. A slight movement will be felt if the piston is loose. To tighten it, the head must be removed.

The piston may be tightened in one of two ways:

1. By adding the required amount of steel shims to allow the pinholes in the rod and nut to line up. If this does not make a permanent repair, it is because the shims have compressed or squeezed out, and the nut is loose again. This may be due to the piston's having been loose for a long time.

2. Then there is nothing to do but to remove the nut, clear out the old shims, replace the nut, and turn it up as tight as possible. It is a good plan in some cases to heat the rod slightly with a torch. Good judgment must be used, however, in doing that. When the nut has been set up tight, a new hole will have to be bored through the nut and rod for the pin.

Regina, Sask. E. W. HALL,
Mechanical Superintendent,
Saskatchewan Co-operative Creameries, Ltd.

863. Crosshead of Ammonia Compressor Breaks.

The crosshead of a 20-ton compressor failed, the boss into which the piston rod was threaded breaking off completely. Instead of searching out the cause, the engineer in charge decided that the accident probably was caused by the machine's taking a heavy slug of liquid ammonia, combined with the possibility that the erecting man had strained the crosshead by setting up too solidly on the nut that locks the piston rod.

A new crosshead having been secured and connected up, the machine was again started. But no sooner was it fairly in motion than the new crosshead was broken in the same place as the first one. Looking, now, for a cause, the engineer gave the wheel of the stop valve in the discharge line a few turns inward and then backed it out to the limit. Feeling assured that there was no obstruction to the discharge, he next explored inside the compressor cylinders but without finding a clue to the difficulty. One of the men then suggested that the bonnet be taken off the stop valve. This was done, and the disk was found off the stem. The valve had been set so that when closed the head pressure would come against the underside of the disk. The object was to permit packing of the valve stem while the condenser was under pressure.

No duplicate of the fractured crosshead was available, and as the delay of casting and machining a new one would have been considerable, it was decided to weld the broken one. The stop valve being properly assembled, and the machine in safe running order, the work of refrigeration then proceeded without further mishap, the welded crosshead showing no signs of weakness.

St. Louis, Mo. A. J. Dixon.

864. Welding Reduces Repair Costs on Ammonia Compressor.

In place of fitting a new piston, we have the old one built up by oxyacetylene welding at a local shop; then it is turned down in our own lathe to the required size. The cylinder is also rebored by our own machinist. In this way, we have been able to keep repair charges on the compressor down to a minimum.

Regina, Sask. E. W. Hall,
Mechanical Superintendent,
Saskatchewan Co-operative Creameries, Ltd.

865. A Jammed Compressor Valve.

A steam-driven, vertical, duplex ammonia compressor started to race, but the oiler got to the governor in time. The connecting rod of the horizontal Corliss cylinder was coupled to the same crankpin as was one of the compressor rods, and this brass began to get hot. The oil was poured on plentifully, but in a few minutes the pin was too hot to touch.

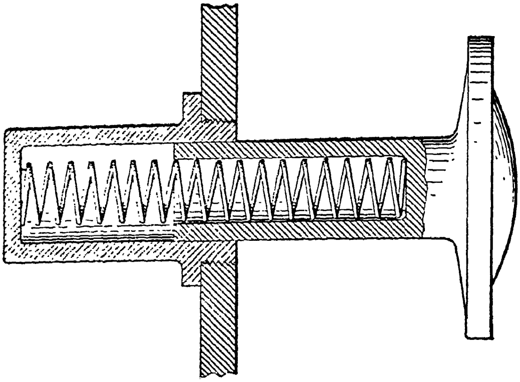


FIG. 275.—Design of compressor valve which jammed.

In the excitement, the men did not notice that the frost was coming off one compressor cylinder, until a chunk of the frost hit the engineer.

The head end of the ammonia cylinders was red-hot. The machine was pumped out, and the cover lifted. A discharge valve was found stuck open. This valve was guided to its seat by a large, hollow, cylindrical stem, wherein a stiff helical spring worked (Fig. 275). Lift of this valve did not seem to be regulated by anything in particular.

The engine ordinarily turned 50 r.p.m., but when it raced, the gas shot this valve up so high that it buckled the spring and swelled the hollow stem out against the guide-nut hole so that the valve was held open.

This allowed one side of the piston of that cylinder to be subject to condenser pressure all the time. As the crankpin brasses were none too plentifully supplied with oil groves, there was nothing left for them to do but run hot, as the oil could not get around the pin.

New York, N. Y. F. P. MACNIEL.

866. Lubricating Ammonia Compressor at Slow Speeds.

Many ammonia compressors depend on the splash system to lubricate the pistons, cylinders, rings, and piston rods. If the speed of the compressor is reduced too far below its intended speed, this method of lubrication becomes ineffectual.

Recently, I learned of a compressor that was slowed from 140 to 90 r.p.m. to reduce capacity temporarily. After a few hours of operation, the two pistons, rings, and wrist pins ran dry and were damaged beyond repair. At the low speed, the crankshaft was turning too slowly to throw oil to these parts.

Of course, this speed is quite a bit lower than speeds usually encountered in ammonia-compressor operation, but it serves as a concrete example of this danger. Therefore, if you intend to slow your compressor down to any extent, check the oiling system and see that it functions at the lower speed.

Beaumont, Tex. R. F. SORRELLS.

867. Vibration of Compressor Records Operation on Thermometer Chart.

The problem was to find through what part of the day our refrigerator compressor was operating. The machine is a 1-ton motor-driven ammonia compressor, connected to our cafeteria box.

We happened to have a 24-hr. portable recording thermometer, which we supported so that it rested on the compressor motor. When the machine was in operation, the vibration was just sufficient to cause the thermometer pen to vibrate, inking a line about 1⁄16 in. wide. When the motor stopped, the pen inked its usual line, which is about 1⁄64 in. wide.

Rochester, N. Y. E. H. LANG,
Rochester Athenaeum and Mechanics Institute.

868. Foundation Bolts for Compressor.

Several years ago, I found it necessary to install a 12- by 24-in. horizontal ammonia compressor which was directly connected to a Corliss engine. This unit was to set on solid concrete to a depth of about 5 ft. My problem was to bolt it down so there would not be any movement of the bedplate.

After considering various schemes for the 1½-in. foundation bolts, I finally decided on making them as shown in Fig. 276.

A is a 1½-in. round iron bar of the required length; *B* is the same bar with the end upset. *C* shows the upset end split, *D* the split end partly opened, and *W* the wedges cut out of 2- by 2-in. square bar.

After we had laid out the bolts in their respective places, we drilled 4-in. holes to the required depth. The holes were dried out thoroughly. We next heated up the split ends to a red heat, with the wedges inserted, pushed the split end down into the hole, and, after it reached the bottom, gave the top of the bolt one or two blows with a mallet, which forced the wedge upward and spread the split ends. While the bolt was still hot, molten lead was poured down the hole until the upset portion of the bolt was completely covered, as shown at *E*. After the lead was cold, a steel bar was used to ram it solidly. When the bolts were all in place the machinery was set up, leveled, and grouted in. The grouting mixture ran in and filled up all the holes above the lead.

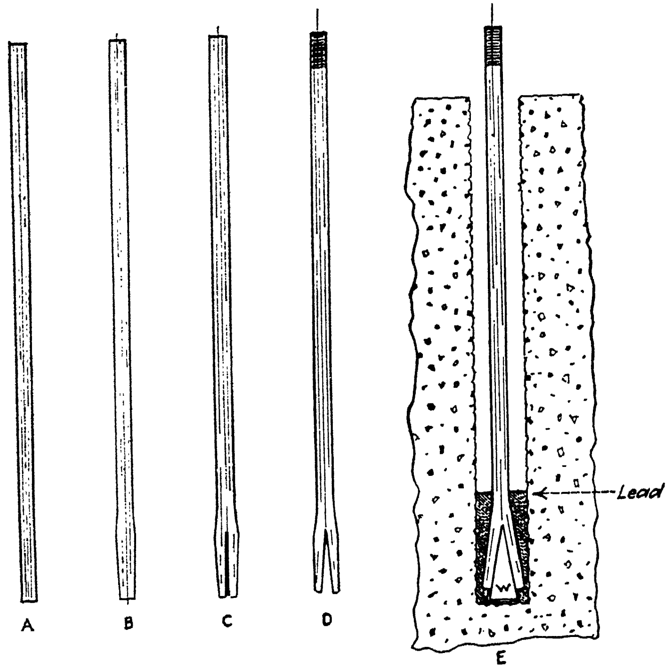


FIG. 276.—Steps in making and placing foundation bolts.

This set has been in operation for the past fourteen years, and today there is no sign of movement or working along the foundation line.

Vancouver, B. C. A. C. GIGER.

869. How the Time Required to Defrost the Coils Was Reduced.

The regular operation of our system calls for circulation through valve 1 to the brine pump, through all iceboxes, and then through valve 2 to the brine cooler (Fig. 277). During defrosting, the exhaust steam is cut into the brine heater until the thermometer registers 50°F. Then valves 1 and 2 are closed, valves 3 and 4 are opened, and the 50° brine circulated through the system, the cold brine returning to the heater instead of to the cooler. The steam is left on the heater to maintain the 50° temperature until defrosting is completed.

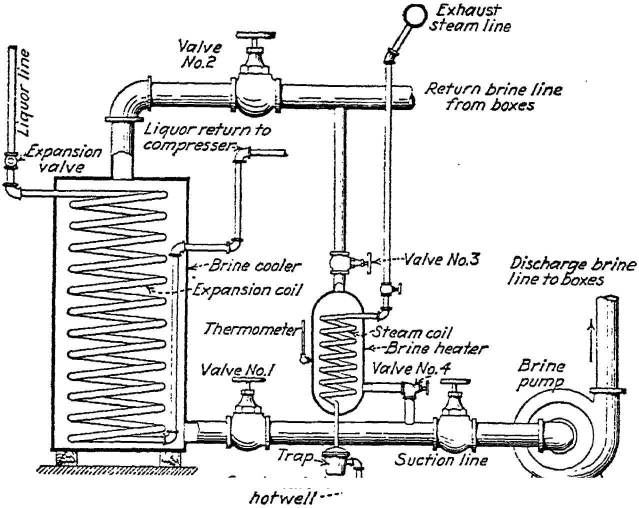


FIG. 277.—Brine is heated with exhaust steam to speed defrosting.

We defrost every two weeks in the summer and once a month during the winter. With this system it takes just 1 hr. to defrost 22 boxes, whereas it used to take 3 to 4 hr. with a hot-water hose and bars. Furthermore, with the present system nothing is disturbed in the boxes. Each box is equipped with a drain to care for the water resulting from the melting of the frost on the coils.

Los Angeles, Calif. LAWRENCE B. BROWN.

870. Preventing Rusting of Refrigerator Valve Stems.

It is often found that valve stems on the cold line in refrigerating plants rust and corrode and become difficult to operate.

A permanent remedy is to have stems of stainless steel. If these cannot be obtained, then a sheet-metal cover should be fitted to give protection from splashes.

The stems should be kept lubricated. For this purpose, we use a mineral oil to which has been added 25 per cent flake graphite. When the stems are worked, if this lubricant is used, the metal will develop a graphite polish, making the valves easier to operate and the stems more resistant to corrosion.

Hertfordshire, England. W. E. WARNER.

871. Quick Defrosting of Refrigerator Coils.

Heavy accumulations of frost had to be removed from the expansion coils in the cold-storage rooms every few days. To expedite the work and save labor the method of melting the frost away by sending hot ammonia gas through the coils was used. By this means as much as 3,500 sq. ft. of freezing apparatus could be cleared of frost in less than half an hour. The temperature of the storage room would go up perhaps 5 or 6°, but the loss would be made up quickly when normal operation was resumed, as the bare surface of the coils would absorb quickly the extra heat.

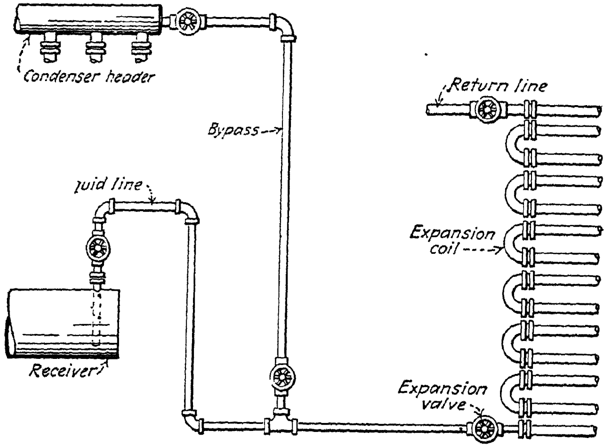


FIG. 278.—By-pass carries hot gas to expansion coil.

The device consisted of a 1-in. by-pass running from the intake header of the ammonia condenser to the line which connected the liquid receiver with the expansion valves, as indicated in Fig. 278. To melt the frost from a set of cooling coils, it was only necessary to shut off the flow from the receiver, open the expansion valve wide, and open the valve at each end of the by-pass. In the meantime, the compressor would be run slowly, and the flow of cooling water to the condenser partly or wholly stopped, according to weather conditions. This was done to get the gas into the expansion coils at as high a temperature as possible.

All expansion valves other than the one attached to the set of coils under treatment were closed during the operation. The valve in the return line from the treated coil also was kept closed until some of the hot gas had condensed. The return valve then was cracked open a little. Thus the compressor got enough suction gas to keep it cool.

St. Louis, Mo. D. J. ALLISON.

872-878. Seven Steps in Scouring Oily Sludge from Ammonia Expansion Coils.

872. The oil separator in the discharge line from an ammonia compressor was not doing the work expected of it. About half of the lubricating oil fed to the compressor cylinders was getting into the refrigerating system. The plant had been in operation for a number of years, and ice output had dwindled to scarcely more than half what it should be, considering the quantity of ammonia circulated. At the end of the ice season the engineer decided to rid the system of the heavy deposit of oily sludge which evidently was clogging the condenser and expansion coils.

873. The first thing that he did was to dig a hole in the ground near one corner of the rectangular freezing tank that stood a trifle lower than the other three. In this hole he set a circular storage reservoir large enough to hold all the brine with which the system was charged. Then, by means of the gate valve and a short run of piping, he drained off the brine (Fig. 279).

874. The next thing was to exhaust the ammonia from the expansion coils in the freezing tank and disconnect the coils from the headers. Having done this, the engineer connected a compressed-air pipe to the upper end of one of the coils and sent a blast through under 100 lb. pressure. But only the air issued from the lower end.

875. Forcing a blast of steam through the coils did not appeal to the engineer, as he reasoned that some condensation might remain after the job was done. He decided to apply heat externally, hoping thus to soften the deposit so that the blast of compressed air could dislodge it. After recoupling the coils to the headers, he filled the freezing tank with water and heated it to about 150°F. by piping in a number of steam jets. Then, after giving the heat plenty of time to take effect, he extended the drain piping across the open end of the brine storage tank and ran the heated water into the sewer. When he again uncoupled the coils and applied the air pressure, he got about a gallon of slime from the set of coils.

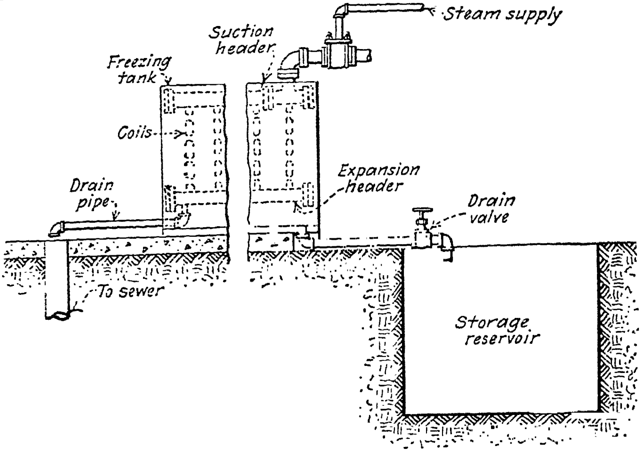


FIG. 279.—Purging freezing coils of oily sludge.

876. It now was plain that the only recourse remaining was to send a strong flow of steam through the coils. The engineer figured that this would be more effective if he left all the coils connected to the headers and blew them simultaneously. By running a 1-in. drain pipe from one end of the lower header, as indicated, he provided an outlet for the sludge. After removing the bonnet from a valve in the suction connection to the upper header, he clamped a steel plate, with a 1-in. nipple screwed into it, over the opening left by the bonnet. This was the steam connection.

877. Having everything in readiness, the engineer turned on the steam, at about 150 lb. pressure. Some minutes passed before there was a showing at the outlet. As the steam melted the oily coating from the pipes, the force of the blast doubtless kept rolling the slime along and banking it up so that its progress toward the outlet was retarded. But suddenly a solid stream of it shot from the outlet nozzle and continued running into the sewer. In a little while the flow began to slacken; but the blast of steam was kept going until only water vapor showed at the outlet.

878. To get rid of the water of condensation that remained in the coils was the next problem. The engineer again disconnected the coils and blew them out, one by one, with compressed air at high pressure. After he had coupled everything up, renewing all the gaskets in the joints, he tested the tightness of the job by first pumping a vacuum in the coils and then opening the valve in the liquid line from the receiver until an ammonia pressure of about 30 lb. had been built up.

Little of the oily sludge had attached to the upper tubes of the condenser, which was of the atmospheric type. This doubtless was due to the comparatively high temperature in these tubes. The oil passed through them as a vapor, some of which condensed in the lower tubes, while most of it went on through the receiver and expansion valves into the freezing coils, where, owing to the low temperature, it formed a semisolid mass.

St. Louis, Mo. A. J. DIXON.

879. Misalignment Causes Fracture of Brine Propeller Shaft.

One of the impeller shafts that circulated brine fractured just inside the gland after the shaft had been in service some 13,000 hr. Examination of the fractured shaft showed slight corrosion, evidently caused by brine's having an acid reaction.

This corrosion was not sufficient, however, to cause the fracture. We found that the shaft had been working out of line. The fracture was a corrosion fatigue brought about by the shaft's having been overstressed in the presence of a corroding medium. External loads on the shaft were light, and the overstress had been totally brought about by the misalignment.

Steel is not a satisfactory material for shafts that have to work in brine. Muntz or Delta metal shafts are more satisfactory.

Brentford, England. W. E. WARNER.

880. Corrosion of Evaporator Coils.

The top evaporator coils in one of our brine tanks became seriously corroded, but only the tubes just below the surface of the brine were affected.

The brine return to the tank discharged a few inches in the air above the brine, and the cause of the corrosion was traced to the fact that air was carried down with the falling brine and brought in contact with the top tubes, the action of this air causing the corrosion. This trouble was rectified by carrying the brine discharge down below the surface of the brine.

Brentford, England. W. E. Warner.

881. Practical Method of Removing Ammonia from Brine Coolers.

In making a change in the construction of a refrigerating plant wherein a shell-and-tube type of brine cooler was submerged in a brine tank, it was necessary to drain the ammonia out of the brine cooler.

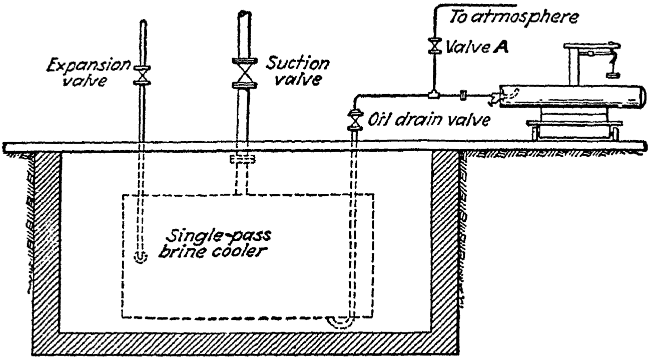


Fig. 280.—How ammonia is transferred from cooler to drum.

An empty ammonia drum is connected as shown in Fig. 280 and placed on a platform scale. The drum is first weighed. Then the scale weights are set at 100 or 150 lb. more than the weight of the drum, according to the size of the drum. The oil-drain valve is then opened, and, owing to the pressure in the cooler, some ammonia is forced over into the drum before drum pressure builds up to the pressure existing in the cooler. The drain valve is then closed, valve *A* opened, and a little ammonia gas is blown off through a pipe leading outside the building. This will cause a big drop in temperature in the drum and a corresponding low pressure. This condition will exist for a short time, so that after valve *A* is closed the drain valve can be opened, and the drum filled with the proper amount of ammonia. A 100-lb. drum is 10 in. in diameter and 7 ft. long, and a 150-lb. drum is 12 in. in diameter and 7 ft. long. Care should be taken not to overcharge the drums, as the gas space may be so reduced as to cause an explosion if the drum should be subjected to high temperatures from normal causes, such as exposure to the sun on warm days.

It is essential that the ammonia drum be connected with the valve pointing downward. This will make the dipper pipe inside the drum point upward. Then when the valve to the atmosphere is opened, only gas will escape, and the temperature and pressure will both be promptly reduced.

Draining the ammonia from brine coolers often presents quite a problem, because if the ammonia is pumped out in the form of gas, the temperature in the cooler may get so low as to cause the brine to start freezing in the tubes, with consequent dangers of tube rupture. If the brine is cold, a pressure cannot be built up high enough to force the ammonia out.

Milwaukee, Wis. R. A. Wheaton.

882. Ice-tank Accumulator Used on Ice Vault.

One plant consisted of two small ice tanks and a vault. The tank coils were operated on the flooded principle, each with its individual accumulator. However, the vault suction came directly into the suction header, and the vault coils were fed by a hand expansion valve. Figure 281 shows the arrangement of the suction system with the two tank-coil accumulators. The valve and pipe *A* were not included in the original installation, with which considerable trouble was experienced with liquor coming from the vault suction into the common suction header.

The vault suction came into the common suction header at a point near the accumulator of one of these tanks. Accordingly, line *A* was installed leading into the accumulator of the tank.

With this arrangement, the vault coils were operated flooded without danger of the liquor's entering the common suction. This liquor was trapped in the tank accumulator and fed to the tank coils. With a reasonable adjustment of the expansion valve on the vault coils, they would operate satisfactorily without further adjustment. An added feature of this installation was that the tank operated automatically from the initial installation; therefore, any additional liquor that came over from the vault was automatically compensated for by the float valve on the tank feed.

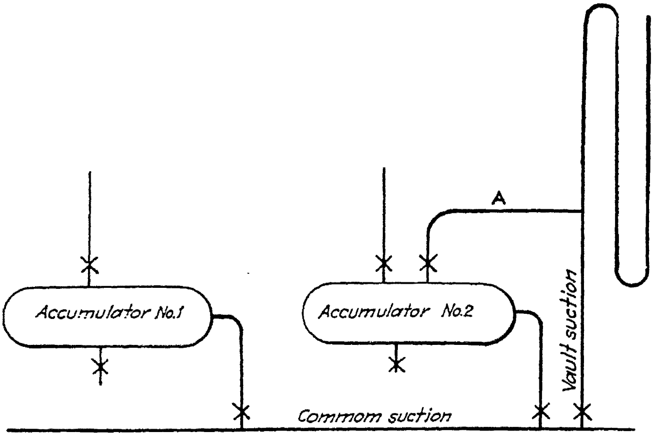


FIG. 281.—Piping arrangement for ice-tank accumulator.

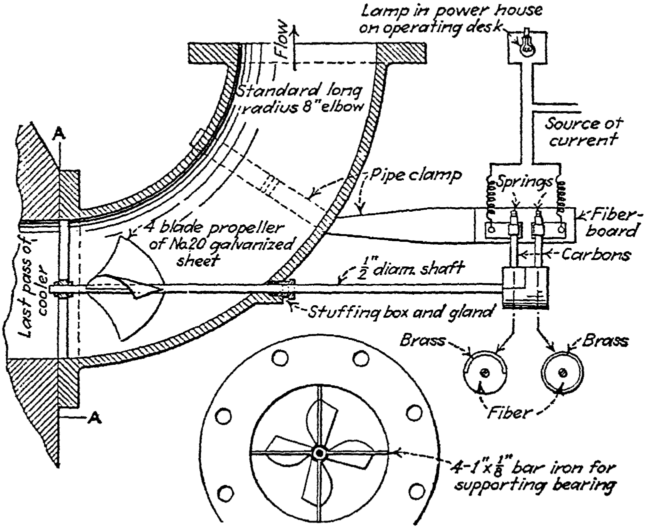
The arrangement seemed to affect in no way the operation of the tank. This was no doubt due to the fact that a sufficiently large suction pipe was included in the original installation to take care of this additional gas. Then, too, any liquor that came from the vault had already been cooled. However, it is not peculiar to this plant that the suction from the accumulator to the header was of sufficient size to handle the additional gas, for such is the case in most similar installations.

Beaumont, Tex. R. F. SORRELLS.

883. Flow Indicator Obviates Freezing of Brine in Coolers.

We have had considerable trouble in our packing plant from coolers' freezing up, causing delay and sometimes expensive repairs. The coolers are of the inclosed shell-and-tube type, with six passes, each pass consisting of a bundle of 42 2-in. diameter tubes. Each cooler is of 150 ton capacity, and four of them are connected in a battery.

The circulation indicator shown in Fig. 282 was developed to warn the engineer when a cooler is in danger of freezing up. Whenever the electric lamp, corresponding to one cooler, remains bright or dark for any length of time, the man in charge knows that something is wrong and can take the proper precautions.


Lamp in power house on operating desk
Flow
Standard long radius 8" elbow
Source of current
A
Pipe clamp
Springs
Fiber-board
4 blade propeller of No.20 galvanized sheet
$\frac{1}{2}$" diam. shaft
Carbons
Last pass of cooler
Stuffing box and gland
Brass
Brass
Fiber
A
4-1"x$\frac{1}{8}$" bar iron for supporting bearing

Front Elevation at A-A

Fig. 282.—Details of indicator to show when circulation stops in cooler.

When the lights of each of the coolers oscillate at the same rate, the battery is giving best performance.

São Paulo, Brazil. Adolf von Euw,
Armour of Brazil Corp.

884. Ammonia Leaks in a Brine Tank of a Refrigerating Plant.

Through a leak in the coils we discharged probably 200 lb. of ammonia into the calcium brine and attempted to counteract this ammonia with muriatic acid but were not successful. Within a week after ammonia was first discovered in the brine, the brass rods of the brine pump had been attacked to such an extent that the pump had to be taken apart, and the rods turned down. We immediately discarded the old brine containing the ammonia, since there were a number of brass valves on the brine line which in a short while would have been ruined.

Raleigh, N. C. R. M. ROTHGEB,
Plant Engineer, State Hospital at Raleigh.

885. Care of Ice Cans and Tanks When Out of Use.

When an ice tank is taken out of service, cleaning, followed by painting or oiling, is the practice recommended in England. If the brine tank is to be out of use for some time, the existing brine is drained off, and the tank and coils are cleaned. The parts of the coils which will not be covered by water are painted. The tank is then filled with water to the normal brine level, additions being made to maintain this level if necessary.

Leaving the brine in the tank is not recommended; the protective film which forms will protect against corrosion only at operating temperatures. Also, there will be a slight evaporation which will lower the brine level and cause corrosion at that level. The temperature of the brine when laid up will be considerably higher than when operating normally, and this will also tend to cause corrosion.

Welwyn, England. W. E. WARNER.

886-888. Three Corrosion-prevention Methods in Brine- and Ice-making Tanks.

886. Best results are obtained, if, in making up a tank full of brine, the water with the treatment in it is reduced in temperature below 40°F. before introducing the calcium chloride or sodium chloride for making the brine. This is very important, as warm brine is corrosive. In fact, practice has disclosed that if this precaution of cooling the water before making the brine is not followed, galvanizing on the ice cans may be severely attacked before the plant has started to make ice.

887. Approved procedure is to place the cans in the tank, fill them with water, and then run water into the tank, allowing sufficient leeway for the addition of the calcium or salt. One hundred to 125 lb. of commercial sodium dichromate should be dissolved in the water in the tank for every 1,000 cu. ft. of brine in the tank. Slightly greater amounts of sodium dichromate up to 200 lb. per 1,000 cu. ft. of brine should be used, if the brine is made with sodium chloride.

888. It has also been found best to throw away old brines that have been subjected to ammonia leaks, if new cans are to be placed in the tank. Brines contaminated with ammonia and treated with muriatic acid to reduce alkalinity are usually very corrosive. Likewise, in old installations where cans are leaky and coils are thin owing to rust, the treatment of the brine with sodium dichromate will clean off the rust to such an extent that leaks and consequent trouble may result. Extreme care and judgment must be observed in these cases.

Milwaukee, Wis. R. S. WHEATON.

889. Corrosion of Condenser Coils.

With refrigerating condensers, there is often a short length of pipe at the coil ends which is alternately wet and dry. This is favorable to rusting and corrosion of the metal. The remedy is to scrape off any rust and clean the pipe from the flange at the header to a point at which the pipe is continually wet. The pipe should then be painted with bitumastic paint over the whole area which has been cleaned.

While this paint is still wet, a strip of canvas should be wound over the coil spiral fashion. This canvas should be given a coat of bitumastic paint; then a second layer of canvas should be wound over the coil in a similar manner to the first. As soon as the underlying paint is dry, the second canvas layer should be painted. This will give effective protection. The paint will effectively seal the canvas to the metal.

Hertfordshire, England. W. E. WARNER.

890. Check Valve Stops Waste of Condensing Water.

Cooling water for a double-pipe condenser attached to a refrigerating system came from the city main under a pressure of about 40 lb. The supply was taken through a branch running off from the main pipe, through which the house and boiler-feed pumps also were supplied. A centrifugal pump circulated the water through the coils of the condenser and back to the main suction line. Running off from the section of the circulating pipe leading back to the suction main was a branch to the sewer. In this branch was inserted a thermostatically operated diaphragm valve for controlling the overflow. When the temperature of the circulating current issuing from the condenser became too high the thermostat would act to open the diaphragm valve. By thus giving a portion of the water free escape, the flow through the condenser would be speeded up.

Although the object of the arrangement was to decrease water consumption, it was apparent from the beginning that a radical defect existed, for the meter in the waste pipe continually registered higher than the meter in the supply pipe. Investigation disclosed that the cause lay with the gate valve near the junction of the return pipe with the suction main. The excessive flow registered by the overflow meter was due to occasional throttling of the circulating current, as the inlet temperature would permit, by means of valve *A* (Fig. 283). When this was done, the pressure from the street main would force the diaphragm valve open against the tension of the spring and permit of a considerable flow of water to the sewer. Removing the gate valve and inserting a swinging check valve in its place solved the difficulty.

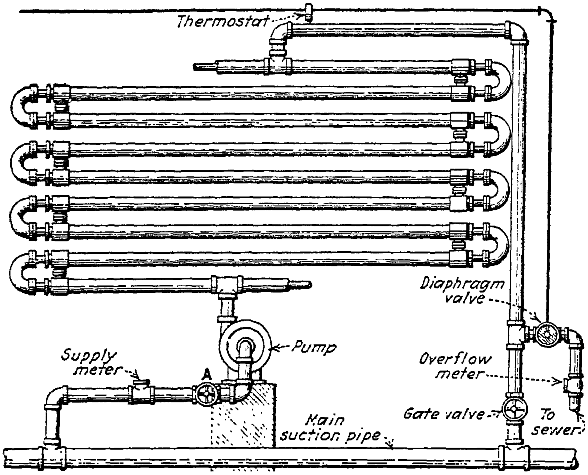


FIG. 283.—Water connections to double-pipe condenser.

St. Louis, Mo. A. J. DIXON.

891. Improved Method of Installing Discharge-gas Heater.

Discharge-gas water heaters are installed in ice and refrigerating plants to obtain a supply of hot water by abstracting the superheat of the discharge gas from the ammonia compressors and to remove practically all of the superheat of the discharge gas, thus adding to the capacity of the condenser. Furthermore, they have proved themselves to be the most effective oil trap so far developed. It is necessary that a certain rate of water flow be maintained and that the means of adjusting this flow be convenient to the operator and solely under his control.

An installation where due regard has been given to accessibility and where the operator has complete control of the necessary adjustments to obtain the correct rate of water flow for each operating condition is shown in Fig. 284.

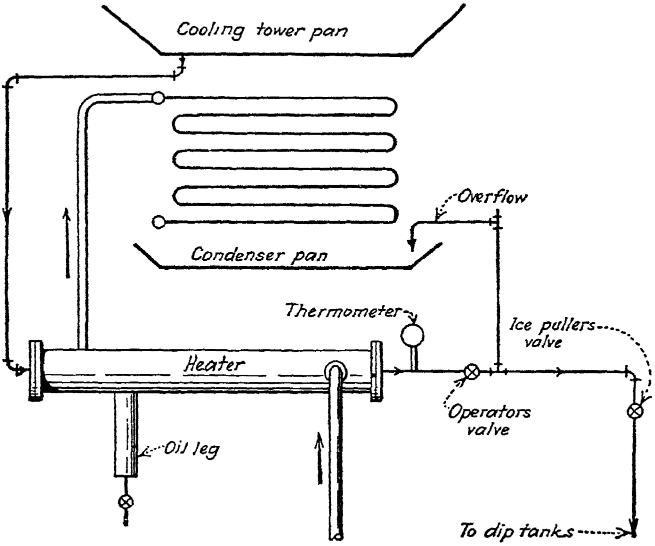


FIG. 284.—Heater connections arranged to give operator independent control of water flow.

A thermometer and a valve in the water outlet permit the operator to adjust the flow independent of the ice puller and thus keep the heater working at a uniform rate regardless of the demand for hot water. It is apparent that the maximum flow is determined by the operator; and should hot water demand fall below this, the surplus will overflow into the condenser pan.

Chicago, Ill. JULIUS BRODSKY.

892. High Pressure for Ice-can-water Agitation.

In a plant employing high-pressure can-water agitation, the idea was conceived of lowering this initial compressor pressure in order to save on the power of compression. Accordingly, this pressure was reduced from 35 to slightly less than 25 lb. per square inch. The same can pressure of 15 lb. was maintained by changing adjustment of the reducing valve.

Coming on duty to take the evening watch, I was told of this change in the operation and gave it little concern. However, when on an inspection about 4 hr. later I noticed agitation slowing down on a great number of the cans, I gave the matter more serious thought.

With the reduced pressure on the air compressor, the moisture was not being sufficiently removed from the air and was freezing in the can fittings. Accordingly, I increased this pressure to 35 lb. again and prevented a continuation of this freezing.

The "saving" of the power of compression was lost, but the ice did not freeze white. Needless to say, no one attempted to make this saving again.

Beaumont, Tex. R. F. SORRELLS.

893. Reducing Cost for Water in the Ice Plant.

We have two 7- by 7-in. twin-cylinder, vertical-type ice machines with water jackets. We use city water for cooling, and this water was wasted to the sewer until we made some changes in the system.

The discharge line from the jackets was run to a 50-gal. tank in the boiler room. This tank was connected by a ¾-in. line to our feed-water heater, and this allowed us to use this jacket water, which was formerly wasted, as make-up feed for the boilers.

We also made a change in the cooling system for the ammonia condenser. The cooling water was taken from the house tanks, on the roof (elevation, 150 ft.). The water is supplied to these tanks by a centrifugal pump, belt-driven from the motor that drives the ice machines. In the summer, this water was used over and over again, without a chance for cooling, and when it became too warm for use in the condenser, it was necessary to use water direct from the city main and waste it to the sewer. To eliminate this waste, we made a 2-in. connection from the soft-water side of the water softeners to the city water connection at the ammonia condenser. The softened water is first passed through the condensers, then through the pump to the roof ranks. If more water is drawn from the tanks than is being passed through the condenser, the main house pumps cut in and supply the difference.

Los Angeles, Calif. LAWRENCE B. BROWN.

894. Discolored Ice.

Upon investigating various complaints in plants where the exhaust steam is used for ice manufacturing purposes, I have found that nearly always the trouble has been due to dirt or matter's collecting in the system and has not been due to oil. However, I have found a few cases where oil had been responsible, owing to poor separators on the line. In such cases, the discoloration was always present in a fan shape at the top of the cake and not near the center parts, which is natural, taking into consideration that oil will attempt to seek the upper level when in the presence of water.

Of course, one is always "between the devil and the deep sea" when using exhaust steam for ice-manufacturing purposes, so far as discoloration is concerned. When one operates on a straight mineral oil, the consumption of cylinder oil is bound to increase, especially if wet-steam conditions are met with. On the other hand, when compounded oils are used, it is difficult to remove it in the reboiler, and consequently the ice becomes discolored. The best thing to do is to consult oil companies specializing in lubrication.

Chicago, Ill. M. H. STRINDLER,
Lubricating Engineer, The Texas Company.

895. Recirculates Brine to Dissolve Calcium Chloride.

The usual method of mixing calcium chloride into a brine solution is by either stirring it direct into the brine or dissolving it in hot water and then mixing in. In the plant where I am employed, we use a different method that not only gives better results but is simple to operate.

On the discharge side of the brine pumps, we disconnected a thermometer and inserted a ½-in. nipple and angle valve. This thermometer was not necessary for operation, as there is another on the same line where it leaves the brine tank. When calcium chloride is to be dissolved into the brine, four ice cans in the center of the brine tank are removed. Over this space is placed an empty barrel with holes punched in the bottom and part way up the sides.

The barrel is filled with calcium chloride, and a pipe run from the valve at the brine pump into the top of the barrel. Flow of brine into the barrel is controlled by a ½-in. globe valve at the end of this pipe. When all the calcium chloride is dissolved, the valve at the brine pump discharge is closed, the pipe is disconnected, and the ice cans are put back into place.

Chicago, Ill. Abe Rocklin.

896. Electric Heat Used in Cold-storage Rooms.

At the Hennesy Brothers plant at Helena, Mont., it is so cold in winter that the refrigerating machine used to cool the meat-storage room may not run for several days at a time. When the machine does not run for a reasonable portion of each 24 hr., there is not sufficient circulation of air to prevent the meat from spoiling. The problem was to provide some way to cause the machine to operate a reasonable portion of the time. To remedy the situation, York Ice Machine Corp. installed three 500-watt strip heaters, which are put on the line by a magnetic switch controlled from outside the cold room by a snap switch (Fig. 285). To save power, a normally closed relay opens the coil circuit of the magnetic switch when the motor is running. This arrangement prevents the strip heaters' being in use when the refrigerating machine is operating.

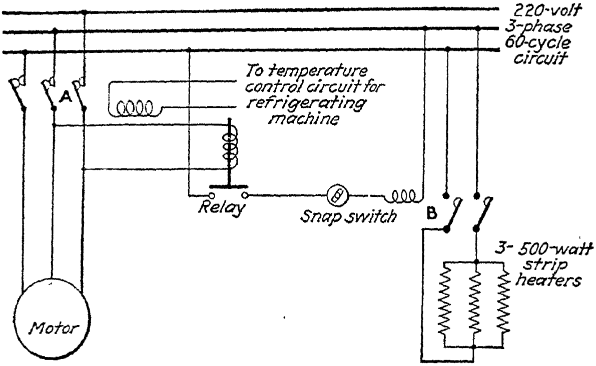

220-volt
3-phase
60-cycle
circuit
To temperature control circuit for refrigerating machine
A
Relay
Snap switch
B
3- 500-watt strip heaters
Motor

Fig. 285.—Motor and strip heater connections.

Denver, Colo. S. J. Kester,
General Electric Co.

897-900. Four Ways of Bettering Heat Balance in an Ice-cream Plant.

We hear and read a great deal about the heat balance in large central stations, power plants, etc., but I have never read anything about heat balance in an ice-cream plant. So I shall endeavor to explain how I have saved a few B.t.us. in our plant.

An ice-cream plant is probably one of the least efficient of manufactories, for several reasons. First we must maintain low temperatures; second, the load factor is low, usually below 50 per cent, as the load depends almost entirely upon the weather; and, third, most of the work is done during a day of about 10 hr. Under these conditions, a proper heat balance is hard to obtain without equipment that would cost more than could be saved.

In our plant, we have refrigerating capacity of 250 tons in ammonia compressors. Our steam boilers have a normal output of 8,000 lb. of steam an hour, but our average steam demand is only around 3,000 lb. an hour. Now the question is, How are we going to make the heat of compression of the ammonia assist our boilers in making steam? One boiler is operated usually from 6 A.M. to 6 P.M., and the compressors are operated during the same time.

897. We installed an ammonia desuperheater in the 5-in. discharge line between the compressors and the condensers. This desuperheater is 16 in. in diameter and 6 ft. long, having 42 1¼-in. tubes, rolled in the heads, and three water passes. The water passing through this desuperheater is the boiler feed water, zeolite softened, with a 600-gal. storage tank on the roof maintaining a 12-ft. head of water on the desuperheater. The water after passing through the desuperheater flows to an open-type feed-water heater with a vent to atmosphere. Exhaust from the feed-water and fuel-oil pumps and condensate returns from the pasteurizers also enter the heater.

898. The average rise in temperature of the water passing through the desuperheater is 72°F. This temperature varies with the load on the boilers, which determines the rate of water flow; with the load on the compressors, which determines the ammonia flow; and with the temperature of the ammonia gas passing through the desuperheater. To get the most from this system the operators must control the suction superheat within narrow limits which have been laid out for them. The average day's run requires about 21,350 lb. of water for boiler-feed make-up, all of which passes through the desuperheater. If this water is heated 72°, we have recaptured 1537200 B.t.u. and have relieved our condenser and cooling tower of that much load. If we consider a 10° rise in feed water as equal to 1 per cent saving in fuel, we have saved 7 per cent on our fuel bill.

899. There are other advantages to a desuperheater and feed-water heater. We have better oil separation from the discharge gas, which is a great advantage in a plant which maintains low temperatures; the separation is obtained by the lowering of gas velocity and cooling at the same time, which has the same action as an air dehydrator and will precipitate the liquid which the gas contains. The discharge line is 5 in., and when it enters the 16 in. the velocity of the gas is reduced in proportion to the increase of area, about 10:1. The gas, at the same time being cooled by the water passing through the tubes, precipitates the entrained oil. Another advantage is the reduced disintegration of the ammonia, thereby causing less noncondensible gas in the system and a lower head pressure.

900. In a steam-driven refrigerating plant, a greater saving could be made with a system just described, but even in our own we feel that it has justified the expense.

San Francisco, Calif. M. E. BELL,
Chief Engineer, Golden State Milk Products Co.

CHAPTER XVI

WATER POWER

901. Predicting Stream Flow.

When examining stream-flow and precipitation records, it has been noted that certain cycles of high and low flow occurred but that they were not, apparently, consistent, nor could any definitely accurate attempt be made to forecast future occurrences, owing to the lack of a known base to work from. The cycle of maximum and minimum sun spots apparently furnishes such a known base, and by extrapolation it may be possible to obtain a fairly accurate measure of future conditions.

The relation between the maximum and minimum sunspots and river-flow data does not in all cases obey the same laws. It is necessary in each location to establish some relation between the two factors that will be more or less consistent.

Shawinigan Falls, Que. W. R. Way,
System-operating Engineer, Shawinigan Water and Power Company.

902. Stream-flow Prediction.

In connection with river developments, many engineers are interested in runoff forecasting but more particularly for low-water periods. In this direction, I have made an attempt which proved rather successful. Low-water foreknowledge is important for large plants operated independently. The watershed area in such cases is large. I had an idea to determine for the site of our plant the lag of runoff, excluding spring months of high water and precipitation falling as snow. This lag, as found for a basin area of 174,000,039 sq. m., was 9.5 months.

Then, if runoff data are displaced 9.5 months behind the precipitation, the two curves are brought into quite close relation. The coefficient of correlation equals 0.83, which is very high. This connection makes it possible to forecast, after careful investigations, the runoff for low-water periods from precipitation taken about a year ahead.

Moscow, U.S.S.R. T. MARETSKY,
Chief Hydrogist, Nijne Dnieper.

903. Assembling a Water-wheel Generator under Difficulties.

A power company designed a powerhouse for vertical generators driven by water wheels. Later, it was decided to lengthen the generator shaft and bolt the wheel directly to a forged flange on this shaft extension.

This made material savings in costs, but the height of the crane rails had been determined, so the *original* shaft would swing over the top of the stator frame. The new shaft was several feet longer. The erector discovered this when erecting the machines and had to get the fields in as best he could.

The two sections of the armature were erected on temporary blocking, with space enough between them for the coupling to enter. The field was then swung in and left hanging on the crane, while the two halves of the armature were jacked and bolted together and to the base plates.

Cribbing was then securely placed across the stator frame to support the rotor. The joint coils were installed and connected with the field resting on this cribbing.

The field was then lifted, the cribbing removed, and the field lowered into place.

Repairs to the armature or periodic cleaning can be accomplished by raising the field and blocking it as in installation, and the water-wheel runner can be lowered on the seal rings by jacks and bolts when necessary.

Schenectady, N. Y. N. L. REA,
General Electric Co.

)04-908. Five Points on Tests Made without a Tachometer.

The method used in checking settings of a speed relay mounted atop a generator shaft in an automatic hydroelectric plant may be of interest. There were three sets of relay contacts: restart contacts set at 85 per cent speed to prevent restarting until the machine had slowed down sufficiently to insure proper sequence in starting; synchronizing contacts set at 96 per cent speed to complete the circuit to close the generator breaker for selfsynchronizing by connecting the generator to the system; overspeed contacts set at 128 per cent to shut the machine down should it overspeed.

904. Arrangements were made with another hydro station upstream to tie one of their machines to ours through a transmission line and, with both fields separately excited, to bring them to speed together. Separate excitation using the motor-generator set left the direct-connected exciter free on our machine. This was separately excited from the control battery, and a 150-volt voltmeter was connected across its armature. The upstream station controlled speed and voltage of the generators, holding the speed in synchronism with the system by means of their synchroscope, while we adjusted the field of the separate exciter to give 100 volts at the armature corresponding to the 100 per cent speed

905. The upstream station operator then raised the speed until the overspeed contact closed while we watched the voltmeter which now acted as tachometer. The overspeed contacts closed when the voltmeter indicated 128, which was equivalent to 128 per cent normal speed. The speed was then lowered to synchronism, and we read 100 volts to check calibration. Continuing to lower it, we read 96 volts when the synchronizing contacts closed and 85 volts when the restart contact closed. Running the speed up and down several times, checking at synchronism each time, gave us a very accurate test of the speed relay.

906. We are also able to adjust the voltage regulator while running as a synchronous condenser and set the voltage-adjusting rheostat at such a value that the generator would supply its share of wattless current when it was tied automatically to the system. Phase rotation of the generator was also checked at this time.

907. In connecting current and potential transformers, we followed the phase rotation marked on the print, and by tracing the main leads back to the generator winding and knowing the direction of the rotation of the water wheel we were able to assure proper operation of power-factor meters, relays, and other such devices.

908. The machine started automatically 2 hr. after the first attempt. Governor setting was responsible for its tripping on the first trial. After a 3-hr. run, the unit was turned over to the system operator. From then on, we got it at odd hours for final adjustment of the various relays.

Montague City, Mass. MAX PAFENBACH.

909. Removable Dam for Hydro Plant.

A new bridge became necessary for spanning a head race something over 60 ft. wide, and for cases of emergency and repairs it was desirable to have, at the bridge, some means of stopping out the water from the mills below. A series of head gates across the stream was considered, but the plan was abandoned

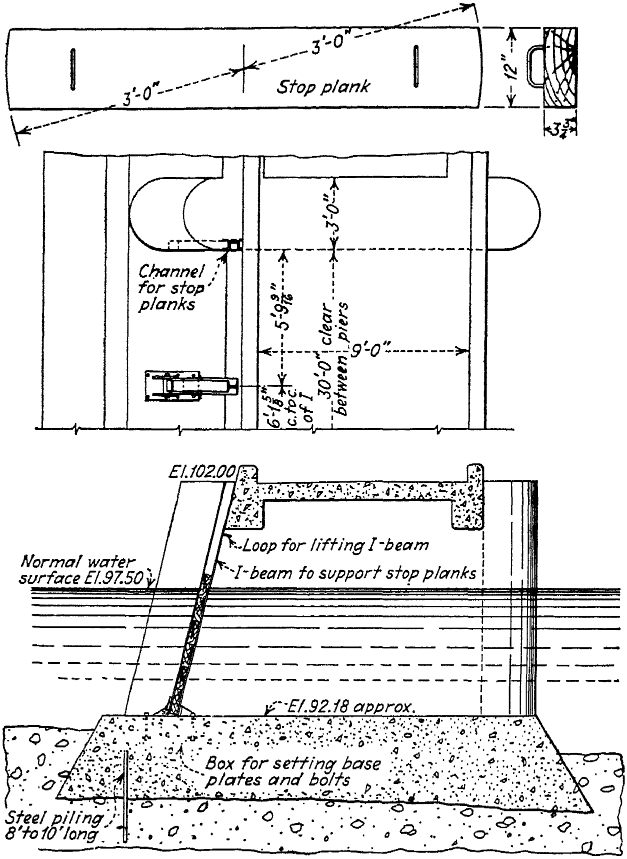

3'-0"
3'-0"
Stop plank
12"
3¾"
3'-0"
Channel for stop planks
5'-9 9/16"
6'-1 5/8" c. to c. of I
30'-0" clear between piers
9'-0"
El.102.00
Loop for lifting I-beam
Normal water surface El.97.50
I-beam to support stop planks
El.92.18 approx.
Box for setting base plates and bolts
Steel piling 8' to 10' long

FIG. 286.—Details of removable dam for hydro plant.

because of high cost and the objectionable appearance of gate stems.

A cofferdam was constructed, and the site unwatered. A line of steel sheet piling was then driven across the stream, the ends being allowed to project some distance above the stream bed, as in Fig. 286. The piling was then capped with a massive concrete mattress extending from shore to shore and made several feet wider than the proposed bridge. On this mattress, concrete shore abutments and a central pier were cast, to support the reinforced-concrete bridge. Parallel to, and several feet upstream from, the upstream face of the bridge, a row of castings, spaced at regular intervals, were anchored in the mattress, and to these castings were hinged heavy steel I beams, to act both as supports and as grooves for stop planks. The I beam when in operating position had a slope of about 30 deg. from the perpendicular, and the top ends were made even with the surface of the bridge curbing. Channel irons were embedded in the sides of abutments and the central pier to support the ends of the terminal stop planks.

When not required, the I beams are submerged by pushing them over a short distance out of plumb, when they will, of their own weight, swing down and rest on the bottom. To facilitate swinging the I beams into place a substantial loop was riveted to the downstream face of each at a point where it would clear the bottom of the bridge. By the use of a pole with hook attached, it is then a simple matter to raise the I beam.

The stop planks are 6 ft. long, and so accurately were the I beams spaced that the planks are everywhere interchangeable. Specially formed staples were inserted in the stop planks to prevent their tilting when being handled with poles having specially constructed hooks. Stop-plank ends are curved on a radius of one-half their length. This feature obviates any possibility of the planks' becoming bound during installing or removing.

Milton, N. H. I. W. Jones,
Consulting Engineer.

910. Preventing Penstock Valves from Freezing.

In a very cold climate, water in the nozzle body and a short section of penstock connected to it would freeze if the needle nozzle remained closed long. This was a 1,500-kva. unit, and freezing occurred in a pit beneath the generator-room floor. This was overcome by installing a large, wood-burning stove in the generator room and connecting the flue to the nozzle pit. Sufficient draft was maintained by the water wheels, two or more of which were always in operation. Heating was regulated by a damper.

Irvington, Calif. K. L. Johnson.

911-912. Two Ways to Keep Eels Out.

911. Eels got into the racks and turbine casing, eventually clogging up the casing entirely and necessitating shutdowns for unsavory cleanings. Closer spacing of rack bars was tried without satisfactory results. Then some one suggested making the rack bars alive, believing this would discourage the eels. The individual bars were than insulated from each other, and 55-volt alternating current connected across them. This corrected the trouble.

912. At another plant, a cofferdam frame was built with 1-in. heavy wire-mesh screen confining 8 in. of 1.5-in. crushed stone between the two sides of the cofferdam. This gave fair results, with only a few eels getting through.

York, Pa. J. S. Carpenter.

913. Voltage Control of Small Generators.

Sometimes small water-turbine plants supplying current to small communities are operated without an automatic governor. A man usually watches the voltmeter needle and keeps voltage under control by field excitation. That kind of regulation "gets by" fairly well with moderately constant loads, but there are occasions when the plant gets out of control. The speed increase due to load loss is rapid and may run up to as much as 100 per cent above normal in propeller turbines, with a nearly proportional voltage increase. In such cases, there are usually quite a few lamp burnouts.

I have used a solenoid relay in the field circuit, which cuts in sufficient resistance to keep down the voltage to a point slightly above normal when the turbine is racing. This works well on both alternating- and direct-current plants and acts before the attendant starts to close the turbine gates. Another device used is to have an overvoltage relay connect a resistance bank, usually in the tailrace, to keep the generator loaded.

York, Pa. J. S. CARPENTER.

914. Sprinklers Cut Station Temperatures.

Several revolving lawn sprinklers were installed on the roof of a Southeastern power house, in such a manner that practically the entire surface of the roof was covered by the spray. Water was obtained from the transformer cooling-water system, which is taken directly from the penstock.

By this method, a condition closely approaching a continuous light rain was obtained, the sprinklers being allowed to operate continuously throughout the summer. The roof, dampened and cooled by water, formed an excellent medium for cooling the air within the station.

Maryville, Tenn. C. B. STOUGHTON.

CHAPTER XVII

ELEVATORS

915. Hydraulic Elevator Guide Rails Reinforced with Steel Plates.

In a building with four horizontal-type hydraulic elevator machines, one of the guide rails for the traveling sheaves on machine 2 became so badly worn that it had to be repaired or replaced. (These guide rails are steel I beams, and the traveling sheaves are carried on shoes resting on the lower flange of the beams, as shown in Fig. 287.)

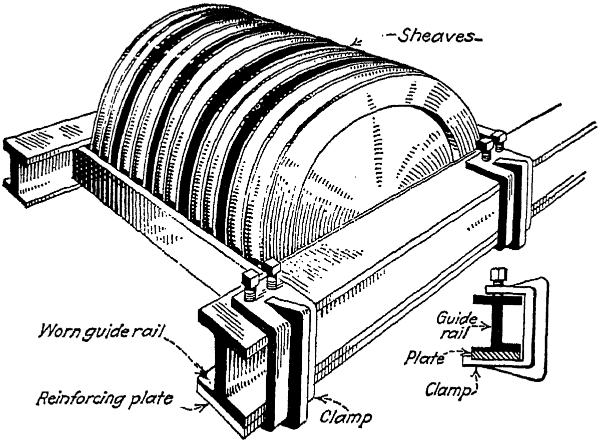


FIG. 287.—Hydraulic elevator guide rails reinforced with steel plates.

To replace the guide rail would have required taking machines 1 and 3 out of service, and the cost would have been about $300. We decided that the rail could be reinforced at less cost. Also, the work could be done when elevators were shut down at night.

Short steel plates ½-in. thick, the width of the guide-rail flange and of a length that would fit between the guide-rail supports, were clamped to the bottom side of the rail. These clamps were cast steel, fitted with two tightening screws, as indicated. It was a simple matter for two men to put the plates into place. One man held the sections of plate against the underside of rail while the other put the clamps in place and tightened them. The job cost about $50, has been in service about three years, and the rails are apparently as serviceable as when new.

St. Louis, Mo. R. K. Rogers.

916. Making Good Joints in Guide Rails.

If care is used in making up the joints on the guide rails, a large part of making a good-looking job is accomplished. The rails match up with a tongue-and-groove joint in the guide section and are held by a fishplate and eight bolts. Bolt heads should all line up squarely. It is not an easy job to do this.

I take a ½-in. packing plate which just fills the space between the bolt heads and the rail. With the bolts loose, the heads are squared, and the plate put into place and held there by a C clamp. This clamp, when tightened, also brings the joint into true alignment. Where tight nuts on the bolts have to be dealt with, this method greatly simplifies the problem, as there is only one wrench to work, and the bolts cannot turn. The same method can be applied to car guide rails, but a thicker packing plate will have to be used.

Bowmansville, Pa. Paul E. Remp.

917. New Brushes Improve Operation.

Every precaution had been taken, but complaints of automatic cars' not landing level with the floor could not be eliminated. Motor-generator sets were cleaned carefully each night, fairly constant temperature was maintained in motor rooms, and motor-generator sets were started each morning and run to warm them up before the load came on. Commutation appeared satisfactory, as at no time was there any sparking. Surfaces of bars were clean, but on damp or rainy days the cars developed more trouble than usual.

The natural graphite brushes had worn about ⅜ in. in a year. This was not excessive but enough to change the brush-contact surface constantly and produce graphite dust that gathered in the commutator slots in an appreciable quantity during a 4-hr. run. This dust created a high-resistance short around the commutator, causing varying-voltage conditions.

New brushes were selected of a grade that would commutate without sparking and would maintain a consistent commutator surface without any appreciable wear or discoloration. They would also carry the high fluctuating current due to starting and dynamic braking and at the same time have a constant contact drop.

Now, stability of operation was maintained under all conditions, and instead of mechanics' cleaning the machines each day, routine inspection once a month is sufficient. With corrected commutation, the cycle of operation is shortened, and the cars make better time (running ahead of schedule) and consume less power.

Bellerose, N. Y. WILLIAM H. CLINE.

918-920. Three Pointers on Ball-thrust Bearings.

918. A small electric elevator developed grinding noise in its gear case. Examination showed the gear teeth badly cut and worn, and the worm shaft had excessive end play. When the worm shaft was removed, the ball-thrust bearings were found destroyed.

Worm-shaft thrust had pounded the balls to pieces after the bearing had worn. Parts of the balls in the lubricant were carried in between the worm and gear teeth, causing rapid wear.

919. When the worm shaft or gearing has excessive end play, its cause should be found and rectified. Trouble of this kind is sometimes indicated by movement of the car when a load is placed on it.

920. Large end play of the worm shafts causes severe hammering of the motor armature as it moves endwise with changes of load. This is likely to bring on electric trouble.

Brentford, England. W. E. WARNER.

921. Oil in Pressure Regulator Improves Operation.

A pump fitted with a regulating pressure governor supplies pressure for our hydraulic elevator. The governor leather washer had to be changed two or three times a week owing to wear at the edges. It occurred to me that if oil were used in the cylinder instead of water, the washer would last longer, so I decided to try it. Before inserting the piston, I filled the cylinder with heavy oil, and since that time I have had no trouble with the regulator. The washers, in use more than three months, show no signs of leakage.

Brooklyn, N. Y. T. J. HARRINGTON.

922-926. Five Helps in Designing a Low-pressure Air Alarm.

922. On several occasions, air pressure has dropped too low to open our elevator doors, a fuse having blown on the air-compressor circuit. To overcome this trouble, we devised the simple electric-bell alarm shown in Fig. 288, which warns when air pressure drops too low.

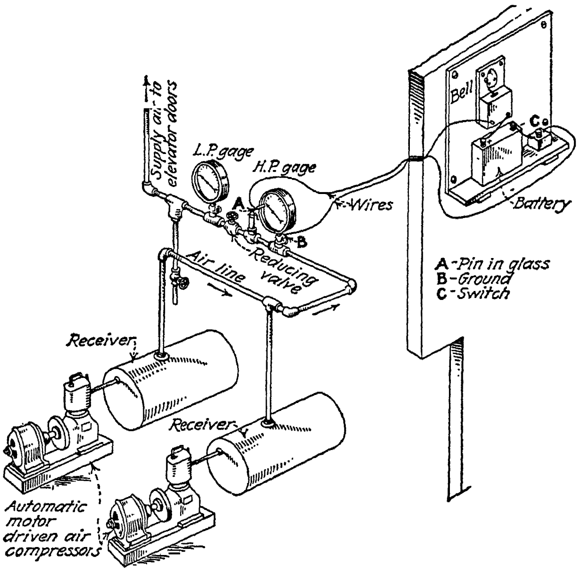


FIG. 288.—Arrangement of low-pressure air alarm.

923. For drilling the holes in the gage glass, we used an old three-cornered file ground to a diamond point, using turpentine on the drill.

924. Terminal *A* can be set to any desired pressure on the gage by simply turning the glass after loosening the rim holding it in place.

925. Low-pressure air is maintained at 35 lb., and the compressor "cuts in" at 45 lb. and out at 70 lb. If a fuse blows in the compressor circuit or the air pressure drops for any other reason, the hand of the high-pressure gage falls back to the pin, thus closing the circuit and causing the bell to ring.

926. The low-pressure point can be set so that there will be sufficient time to get the compressor into service again before the pressure has dropped too low to operate the doors.

Edmonton, Can. C. McEwan.

CHAPTER XVIII

TOOLS

927-928. Tools for Cotter Pins.

Figure 289 shows two tools that were primarily designed for facilitating the task of putting in and taking out cotter pins.

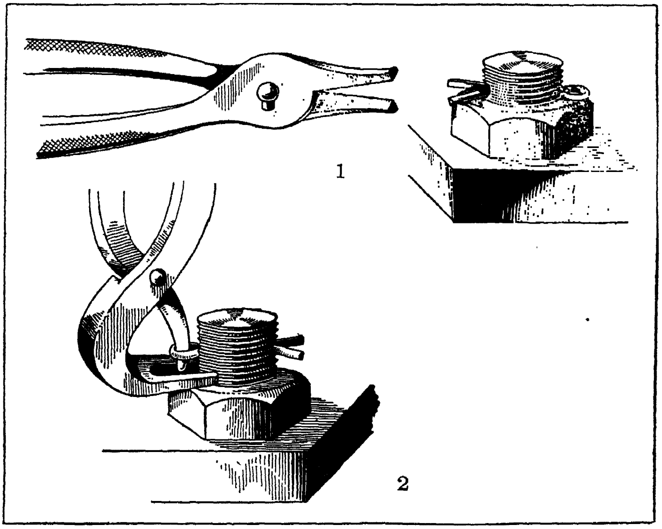


Fig. 289.—Tools for spreading and removing cotter pins.

927. The tool shown in Fig. 289-1 was made by simply grinding the two jaws of a regular pair of pliers wedge shape, as shown. These are handy in spreading the tongues of a cotter pin and are often the means of saving skinned knuckles that occur frequently trying to spread cotters with a screwdriver.

928. The specially shaped tool shown in Fig. 289-2 is easy to forge and will be found excellent for extracting a cotter without drawing it out of shape, so that it can be used again. These two tools will also be found useful for many other odd jobs about the plant.

Concord, N. H. C. H. Willey.

929-930. Practical Methods of Drawing Keys.

Drawing keys that have been tightly fitted or have rusted in is often a difficult job. It is frequently easier to drive the pulley or wheel off the key than to draw the key. Application of heat to the hub will make it easier.

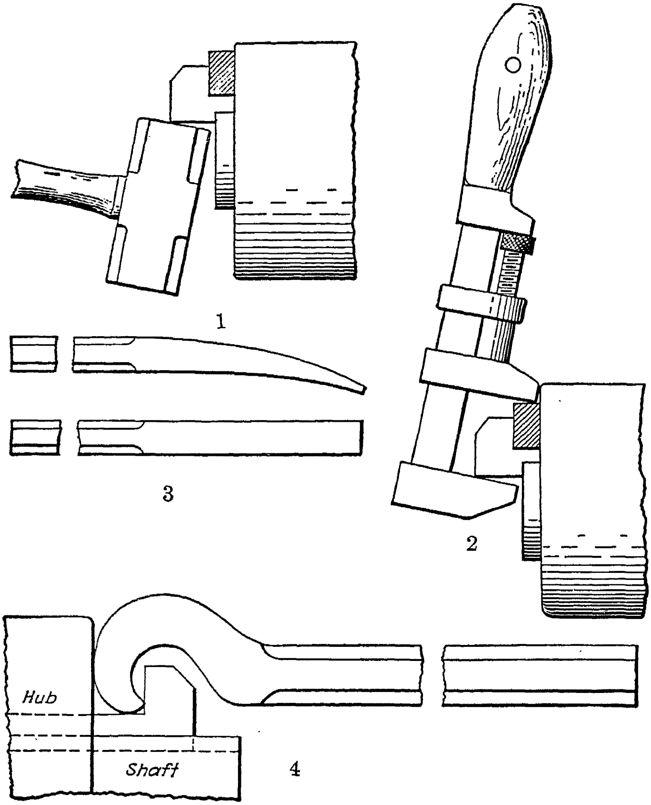


Fig. 290.—Tools for removing keys.

With a key in the position shown in Fig. 290-1, it is usual to hold a sledge under the head of the key to prevent its being bent back by the wedge.

929. A better plan is to use a monkey wrench, as shown in Fig. 290-2. This prevents the head from being bent back and also keeps the wedge from rising and slipping out.

930. A key wedge formed as in Fig. 290-3, with its bottom edge slightly thicker than the top edge to prevent its slipping, is a practical tool; and a key puller, shown in Fig. 290-4, is a useful addition to the power-plant toolroom.

Long Beach, Calif. E. J. JORDAN.

931. Holder for Tube Cleaner Made from Piece of Boiler Tube.

Some manufacturers of boiler-tube cleaners advise that the cleaners be kept in oil when not in use. We endeavored to do this but generally found that the oil bucket supposedly containing the tube cleaner usually contained an assortment of nondescript articles as well or else that it was practically empty of oil.

In order to insure the cleaner's being properly immersed, we took a piece of old boiler tube that was slightly longer than the cleaner and welded a cap on the bottom (Fig. 291). The cleaner was then placed inside and covered with oil. We found that this bath could be easily stowed in the tool locker and that nothing else could be put into the container with the cleaner.

Port Arthur, Ont. R. G. EDWARDS.

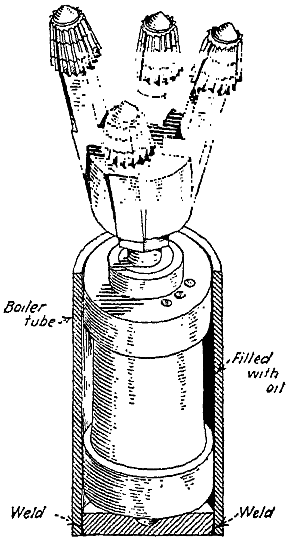


FIG. 291.—Tube-cleaner holder.

932. Self-centering Valve-reseating Machine.

Care in centering reseating machines is essential; otherwise considerable injury will be done to valve seats. I have a dozen different-sized flanges, split bushings, and two screw glands made up, this assortment fitting the greater part of the valves in the plant.

The assembly of the rig is shown in Fig. 292-4. The bonnet and flange on the valve, which is to be reseated, are removed;

then a flange, as shown in Fig. 292-1, is assembled with the split bushing and the gland shown in Figs. 292-2 and -3. The spindle of a reseating machine is next inserted, and a cutter secured. The assembly is then bolted to the flange on the valve, and the screw gland tightened, the split bushing being clamped to the outer sleeve to prevent it from turning. This equipment insures the reseating cutter's being properly centered and no danger of refacing the seat off center. With this rig, one unskilled man can reseat about four valves an hour.

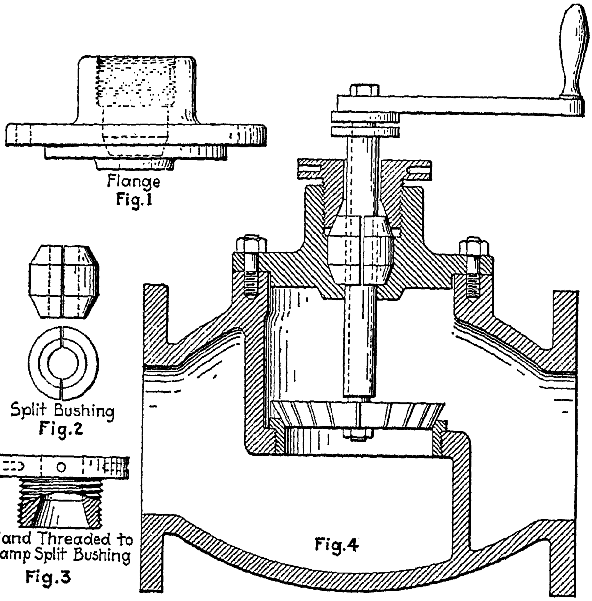


Fig. 292.—Reseater is centered by flange with special gland arrangement

Boston, Mass.

Earle S. Nason,
Chief Machinist, U. S. Navy.

933. Old File Made Key Extractor.

Having 30 machines to take down every year, each with 40 gib keys in the cams, spiral and spur gears, and movement arms, I made the device shown in Fig. 293 from an old file. By the use of this tool, gib keys are pulled about as fast as one may draw nails with a claw hammer. Gib keys are often situated where no other tool or device may be used.

Vancouver, B. C. S. H. Cooke.

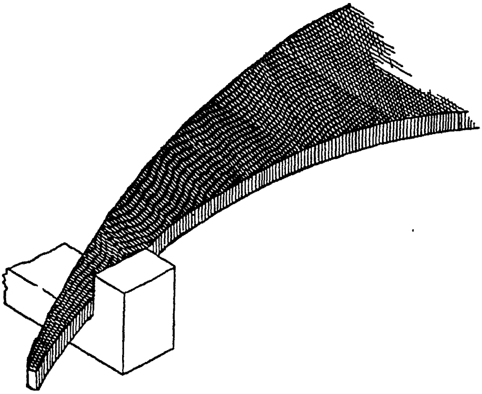


Fig. 293.—Key extractor made from old file.

934. Tool Bin Locked to the Wall.

A theft of spare parts from a tool bin used for holding miscellaneous gaskets, pipe fittings, and tools in a power plant made it necessary to use a lock. To simplify the job it was decided to use the wall as a door for the bin. At one end of the front of the bin two hinges were used to attach the bin to the wall, and at the other end a lock was placed, and four castors inserted in the legs. With the bin locked to the wall, if anything was needed, it was necessary only to unlock it and swing it around a few feet to expose the contents.

Hamilton, Ont. W. H. Moore.

935. Clamp for Anchoring Chain Hoists to I Beams.

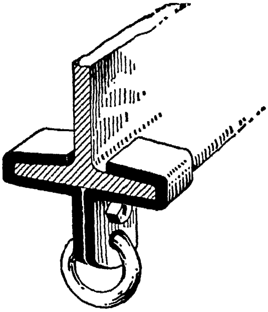


Fig. 294.—Improved I-beam clamp.

In Fig. 294 is a design in use at navy yards and on board ship for safe I-beam clamp rigging. The ring is welded, and the clamp is well fitted and butted together.

Penacook, N. H. Charles H. Willey.

936. Tool for Installing Chain Drives.

While it is a simple matter to stretch a small chain and slip it over the sprocket wheel, it is another problem entirely to connect the links of a heavy conveyor chain of considerable weight. I have found the chain puller shown in Fig. 295 to be just the thing for this job. With the two hook ends, the chain comes together easily when the power of the lever is exerted, and the connecting link may be slid into its groove or the pin inserted in the pintle chain link. This tool will save a lot of bull strength and profanity.

Vancouver, B. C.

S. H. COOKE.

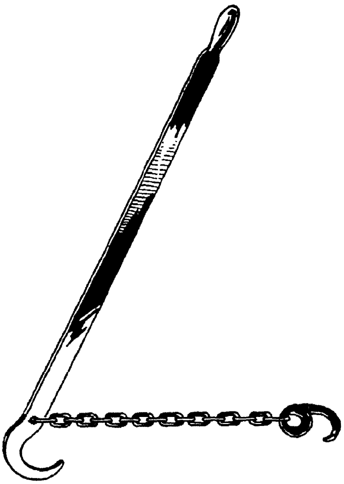


FIG. 295.—Tool for installing chain drives.

937. Easily Made Chain Clevis.

A small clevis comes in handy on many rods, doors, or lever connections operated by light chain. Unless specially ordered, many times this type of clevis is hard to procure. I have used the jaw end of a fairly heavy discarded automobile brake rod with success. Simply saw off the rod and smooth up the back of the jaw on the emery wheel, and the job is done.

Missouri Valley, Iowa. FRANK W. BENTLEY, JR.

938. Emergency Vise Made for Small Pipe or Tubing.

It was necessary to cut off a number of pieces of fairly heavy tubing without a pipe vise. The staple and plate of a hinge hasp for a door were used. The plate was screwed solidly to a bench; then the tubing was slipped through the staple and held firmly with a small wooden wedge. The circuit portion of the staple afforded a good holding contact for the tubing with no danger of crushing or bending it. The staples are always firmly riveted and fastened in the plates so that the tubing can be wedged as tight as necessary to hold it for sawing.

Chicago, Ill. R. O. BROWN.

939. A Handy Oil-container Carrier.

A square 5-gal. oil can is awkward to pour from with the small tin handle that is part of it. Where one has many of these to handle the task can be aided by making a special carrier as in

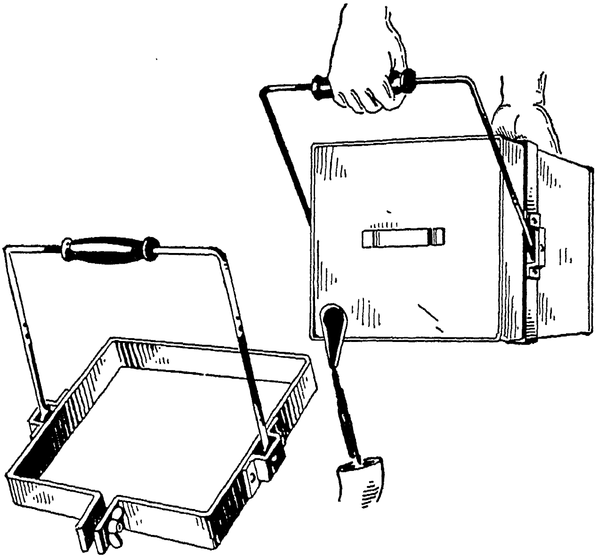


FIG. 296.—Special carrier for 5-gal. oil cans.

Fig. 296. The band is formed to fit a standard square can and has a clamping screw and nut to tighten the carrier to the can.

Penacook, N. H. CHARLES H. WILLEY.

940. A Practical Stud Extractor.

A piece of hexagonal tool steel, two or three nut sizes larger than the stud for which it is to be used, has an extension block forged on one end to take the wedge, as shown in Fig. 297. A tapping hole is drilled through it along the long axis. This tapping hole is counterbored from the base end to a sufficient depth to allow the blank part of the stud to enter far enough for the teeth of the wedge to engage with it. The rest of the hole is tapped to the size of the stud for which it is intended. A regular open-end wrench to fit the hexagon completes the outfit.

By screwing a cup-pointed, hardened-steel setscrew into the top end the extractor can also be used to set studs.

New York, N. Y. F. P. MacNeil.

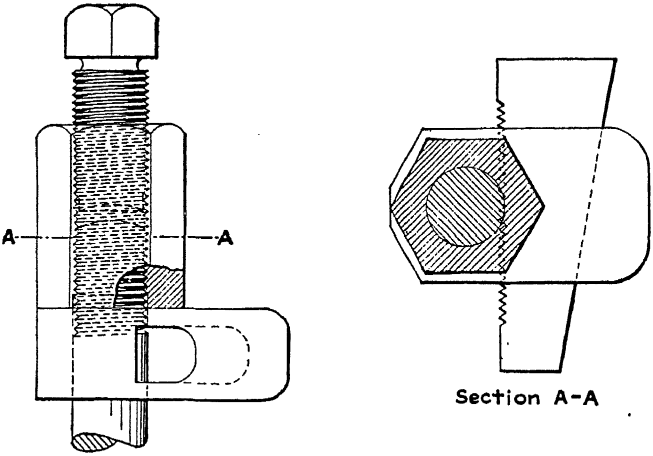


Fig. 297.—Details of stud extractor.

941. Improved Commutator-sanding Block.

An improved sanding block suitable for several sizes of commutators can be made as shown in Fig. 298. It consists of a holder formed of three stout pieces of wood, as at *A*, a sandpaper strip *B* being fixed over the open end of the holder and connected to the two uprights.

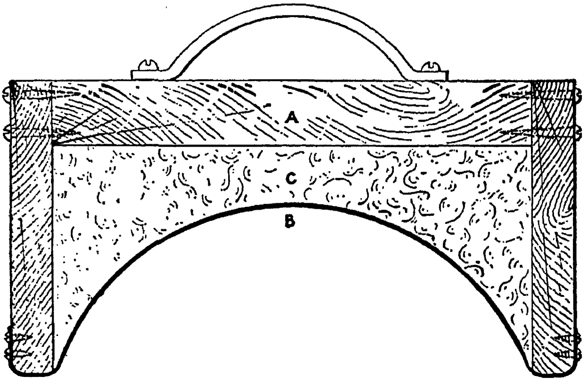


Fig. 298.—Commutator sanding block with flexible filler.

The strip *B* is thus left free to adjust itself to the curvature of the commutator. To make a cushion for the strip, the space *C* is filled with cotton batting, just sufficient to provide a backing for the sandpaper.

Brentford, England. W. E. WARNER.

942. Tube-and-rod Tool for Starting Nuts in Inaccessible Places.

The center shaft of the tool is a piece of round iron or steel, and the outside is a piece of iron pipe. One end of the rod is threaded, and one end of the pipe is sawed and made offset, as shown in Fig. 299. The nut is engaged on the thread a few turns; then the pipe is slipped over, the projection on the pipe preventing the nut from turning.

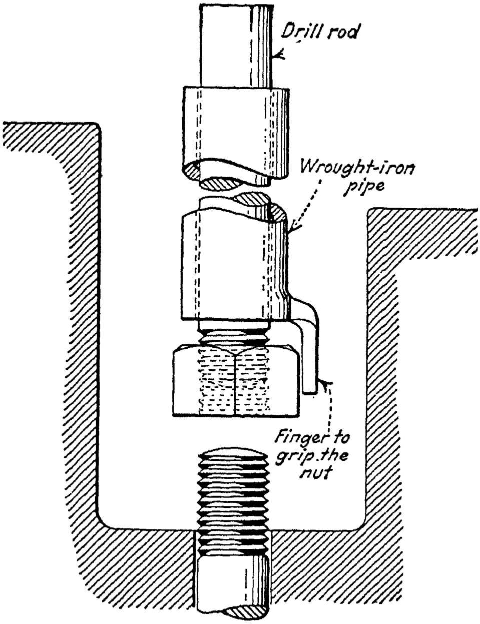


FIG. 299.—Projection on pipe prevents nut from turning, while central rod keeps it from dropping while being started.

Washington, D. C. G. A. LUERS.

943. Hacksaw for Confined Places.

A handle of hardwood, preferably rock maple, with its ferrule tip ½ in. in diameter and ¾ in. long, is sawed with a longitudinal cut-in from one side to ¼ in. past its center, as shown in Fig. 300.

The open edge of this cut may be closed by a thin strip of wood glued in, leaving an opening ½ in. wide, the whole length of the handle, for the hack-saw blade to pass through.

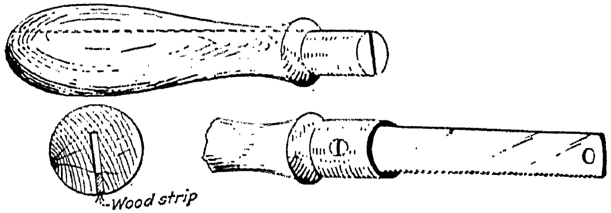


FIG. 300.—Saw blade is slipped through handle and locked with screw.

A ferrule ¾ in. long, ½ in. inside diameter, and 1/16 in. or more in thickness is driven on, and in one side of this a hole is drilled through metal and wood to the center and tapped for a short No. 8 machine screw, to act as a setscrew against the side of the blade.

A whole or broken hack-saw blade may be run through the handle and fastened by the setscrew, leaving any desired length projecting. Care should be exercised, however, in using this tool, as the blade must depend entirely on its own stiffness.

Monrovia, Calif. CHARLES A. PEASE.

944. Tool for Removing Condenser-tube Glands.

The gland-removing tool illustrated in Fig. 301 consists of three parts, with part *A* made the same diameter as the outside

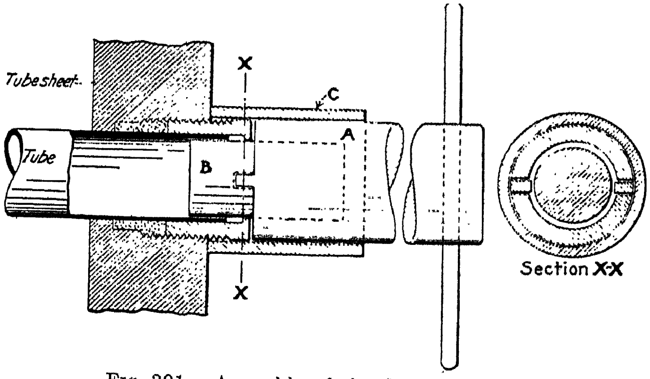


FIG. 301.—Assembly of gland-removing tool.

of the gland. Piece *B* is made a sliding fit in the tube, and sleeve *C* is made to slip over piece *A* and the gland as shown. Piece *B* is made removable from part *A* so that, should one of the lugs break off part *A* or need truing up, it can be done more easily than if it were one piece.

This tool greatly facilitates the work, and glands may be removed without damage to the slots.

Newark, N. J. C. A. LEONARD.

945. Handy Boring Tool for Economizers.

Get a small toothed wheel, turn the teeth in a lathe to a diameter ⅛ in. less than the bore of the pipes, and give the teeth a cutting edge and clearance (Fig. 302). Now fasten this cutter head to a round or square steel bar about 6 ft. long or longer, if there is headroom over the economizer. With a wrench to turn the cutter, you can begin operations; it requires no feeder, as its own weight is sufficient. A guide piece of wood with a hole in the center will keep the boring bar central. With moderately hard scale, six pipes can be easily cleaned in a working day, or more if the economizer is allowed to cool off for two or three days, which tends to soften the scale. With softer deposits of scale, the job is speeded up by running a supply of water through the pipe being bored; where the deposits are very soft, a hand scraper is better than the cutter.

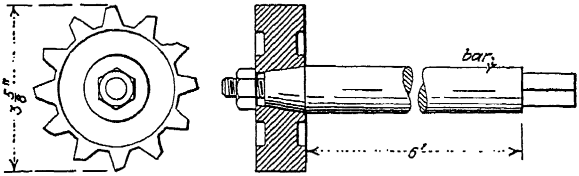


FIG. 302.—Cutter made from a gear wheel.

Stockport, England. A. WINDROSS.

946-947. Two Tools for Cutting Gaskets.

A set of tools for cutting out gaskets is shown in Fig. 303. They are adjustable for varying diameters. These tools will cut through several thicknesses, the procedure being to square out the material and place one atop the other. A board is used to support the material and prevent the tools from being damaged by contact with the drill-press table.

Shanks of the tools are short pieces of cold-rolled steel provided with suitable holes for the cutting tools, which are locked after adjustment with a setscrew.

The cutting tools are round tool steel hand-forged and bent. They are properly tempered after being bent and finished. After the cutter end is forged, it can be finished to shape and brought to a knife-edge before tempering.

A pilot pin made of drill rod pierces the material as the tool is fed down and keeps the inner and outer diameters concentric.

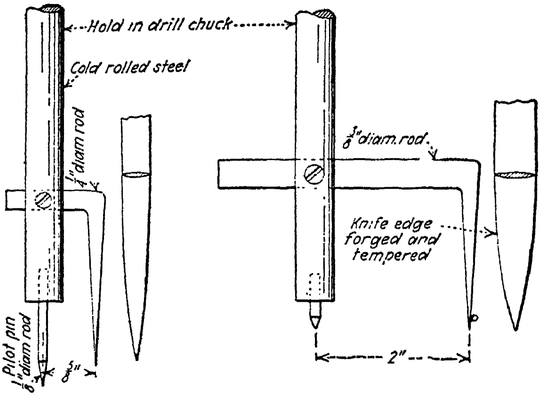


Fig. 303.—Inside and outside cutting tools for gaskets.

The outside circle is cut first. If desired, one tool can be kept for cutting out the hole, while the larger tool is used for cutting the outside.

These tools will give a smooth edge, and when kept sharp they will produce a neater job much more quickly than cutting out gaskets by hand with a knife.

Syracuse, N. Y. H. L. Wheeler.

948. Tool for Cutting Holes in Sheet Metal.

The shank is 5/8-in. round steel, forged at the upper end to fit a brace or the chuck of a slow-speed drill. The other end is turned down to 1/4 in. to form a guide and then threaded to take a 5/8-in. lock nut. A rectangular opening 5/16 by 1/2 in. is cut through the shank to take a cutting tool bar made from a piece of 9/16-in. round steel, the portion which slides through the opening in the shank being shaped to approximately 5/16 by

½ in. The tool is held in the crossarm by means of a lock nut, as shown in Fig. 304. The cutting tool should be ground as shown, so that the outer edge will cut through first, thus leaving a clean-cut hole in the sheet. The cutting tool is made from ¼-in. square high-speed steel.

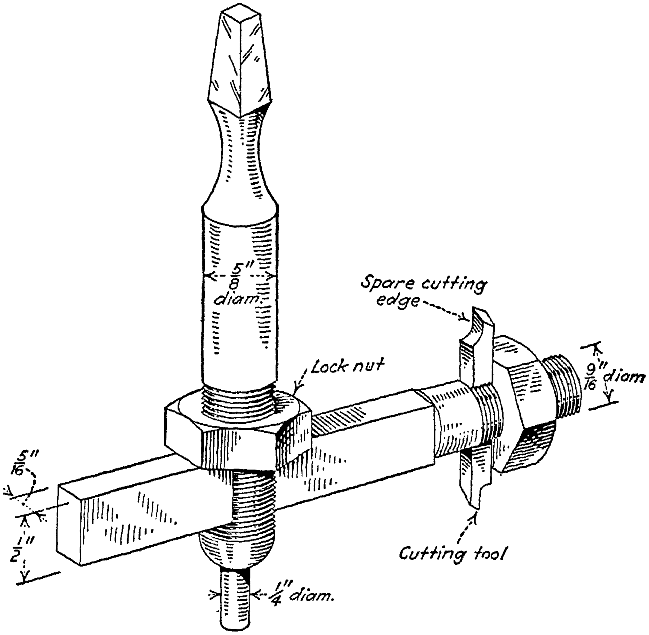


Fig. 304.—Tool for cutting holes in metal sheet.

To use the tool, a ¼-in. hole is drilled or punched in the sheet, the cutting tool is set at the proper radius, and the lock nut on the shank tightened. The guide point is then inserted in the hole, and the tool turned by a brace or other means. All parts are casehardened.

New Westminster, B. C. W. L. Stevens.

949. Winding Small Tension and Compression Springs.

Make a crank from a piece of iron rod of a slightly smaller diameter than the inside diameter of the spring desired. The size depends on the size of wire used and can be easily determined after winding a few springs. The rod is slotted in the end to hold the wire.

To wind the spring, the crank rod is clamped in a vise between two blocks of wood, the slotted end being between the blocks with the slot parallel with the surfaces, as in Fig. 305. The end of the wire is placed in the slot, and the crank turned just enough to hold the wire. Now, if a tension spring is to be wound, the wire is started and wound close by feeding the wire perpendicular to the crank rod. If a compression spring is to be wound, the wire is started to an angle of less than 90 deg. with the rod—the less the angle the farther apart the coils will be. It is important that the first coil have the right angle, as every coil after the first one will be just like it, or symmetrical, and that is what makes a neat spring. A spring of any desired tension can be wound.

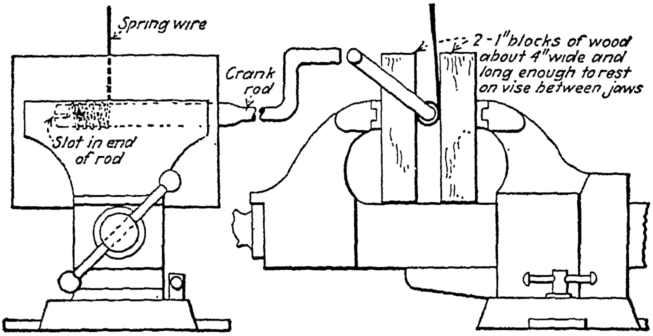

Spring wire
Crank rod
Slot in end of rod
2-1" blocks of wood about 4" wide and long enough to rest on vise between jaws

FIG. 305.—Spring winder in position in vise.

Denver, Colo. F. R. RAWSON.

950. Handy Tool for Making Spiral Springs.

This device consists of a piece of $\frac{1}{8}$-in. round iron stock *B*, bent to form a crank at one end and slotted at the other (Fig. 306). This is held between two pieces of $\frac{3}{32}$-in. fiber *A* by two bolts. To make a spring, the rod is clamped between the two

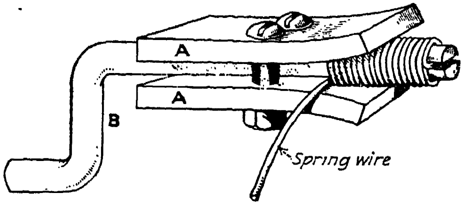


FIG. 306.—Small-size spring winder.

pieces of fiber, with its end about flush with those of the fiber. The end of the spring wire is then placed in the slot, and by turning the crank the wire is forced around the rod to form the spring. As the wire is wound on the rod the turns of the spring force it out from between the fiber pieces. This little device can be held in the hand when making small springs. For larger springs it may be clamped in a vise.

Jeannette, Pa. EDWARD B. BLACK.

951-952. Two Practical Attachments for Blowtorch.

It is possible to improve the operation of the standard blowtorch by using the simple attachments shown in Fig. 307.

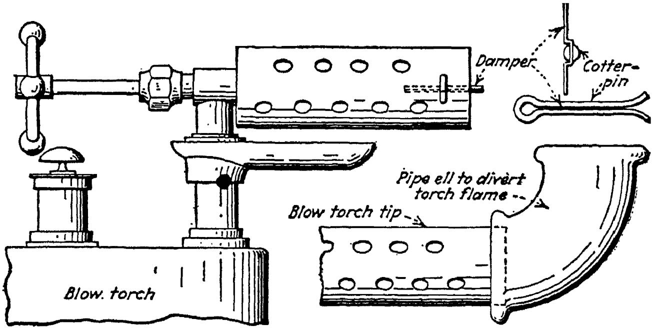


FIG. 307.—Damper and flame deflector applied to torch.

951. When a torch is turned low, it will sputter and get cold, possibly going out altogether. To avoid this, a damper put into the end of the burner, as shown, will conserve the heat, and the torch will be ready for instant use. The damper is made from a piece of sheet iron, cut oval, bent to shape and size of the burner. The damper is turned open or closed, by the cotter pin, which engages the bent portion of the shutter and is placed through opposite holes in the end of the burner.

952. An ordinary pipe elbow over the burner end diverts the flame upward or downward, depending upon the kind of work being done. This device is handy when the torch can be placed adjacent to a job, and the flame directed to the work.

Washington, D. C. GEORGE A. LUERS.

953. Easily Constructed Soldering Pot.

Here is an easily constructed soldering pot for tinning wire ends and similar work. A discarded sun-bowl type electric room heater was available. The heating element consisted of a porcelain bowl, grooved in a spiral on its outside circumference, as in Fig. 308. Resistance wire was wrapped in this groove in the usual manner.

This heating element was screwed in a socket mounted on a wooden base. A snap switch was also mounted on the base, and a 10-ft. length of lamp cord was connected to the switch. A small quantity of fire clay was pressed into the cracks around the lower resistance terminal of the heating element and into the case to prevent any possible leakage of molten solder. This outfit, when filled with scraps of solder, would melt it in a short time and was easily carried in the tool box from one job to another.

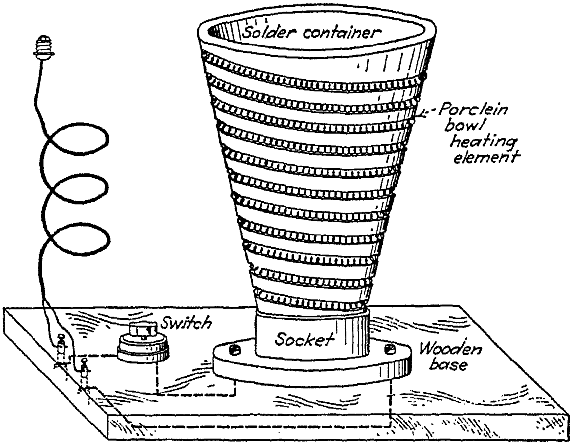


FIG. 308.—Soldering pot made of discarded heater element.

Milford, N. J. HARRY M. SPRING.

954-957. Four Pointers on a Carbon-type Electric Soldering Device.

In Fig. 309 is shown an electrical soldering device that I have found to work conveniently where it is not safe to use a flame for heating. The soldering part consists of a piece of ¾- or ⅞-in. carbon held in a clamp, which is provided with a handle for easy manipulating. The carbon clamp is connected to one side of a low-voltage transformer, and the coil or other device to be soldered is connected to the other terminal of the transformer secondary.

955. To use the soldering device, the carbon is placed on the part to be soldered, and current flows through the carbon and the connection to be heated. This raises the temperature to the melting point of solder. I also use a thin copper wedge that can be heated by holding it against the carbon. This wedge is used to smooth up the solder. A little practice with this equipment will show that it can be used in several ways.

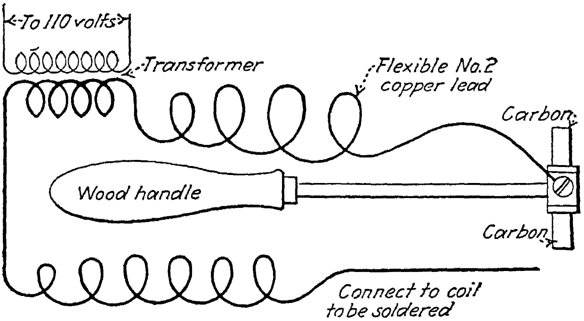


FIG. 309.—Diagram of carbon-type electric soldering "iron."

956. The device is safe and simple, and the current can be varied by regulating the length of the carbon between the clamp and the point being soldered. I have found that the design of this device may be varied to suit the condition of the work. Ordinarily, the length of carbon between the clamp and the joint being soldered will be about 1 in.

957. To supply power for doing the heating, I have used a 5-kw., 2,300- to 115-volt transformer with the 2,300-volt side connected to a 115-volt circuit. This connection gives about 5.5 volts on the low-voltage side. In other cases, I used a 550- to 110-volt transformer, with the 550-volt leads connected to a 110-volt line. This gives about 22 volts, which makes it difficult to handle the soldering carbon to get good results. A low-voltage transformer has been used with satisfactory results. The leads must be of sufficient size to carry the current without overheating or causing too high a voltage drop.

Warrenville, S. C. J. P. MORAN.

958. Soldering Lugs.

In soldering large-size lugs with blow pot, excess soldering paste tends to run over the surface of the metal and become troublesome. One of the best ways to overcome this difficulty is to use a clean cotton rag wound on a stick as a swab. It will be found that the rag takes up all the paste and leaves the surface of the metal clean.

959. Brazing Carbon Steel.

To braze carbon steel for tempering, copper only is used instead of the usual spelter of copper and zinc. No special care need be taken over an ordinary brazing job except that parts must be heated to a higher temperature. Pure copper melts at about 1980°F., while spelter melts at about 1600°. After brazing, carbon steel should be annealed, hardened, and drawn. To anneal low-carbon steel, heat to about 1650°; and high-carbon steel, to between 1400 and 1500° and allow the steel to cool at a rate slow enough to prevent hardening. After annealing, heat to about 1475° and quench in oil and then draw or temper by reheating to the desired temperature or color. It is evident that all the heat treatment given the steel is at a lower temperature than that at which the brazing takes place and therefore does not affect the brazing.

I have used copper for brazing both carbon and high-speed steels for use in milling cutters and reamers and have experienced no difficulty in tempering them later.

Rockland, Mass. BURTON W. WHEELER.

960. Babbitt Melting and Pouring Pot Made of Pipe and Fittings.

A combination babbitt melting and pouring pot is shown in Fig. 310, made of pipe and fittings. A piece of 5-in. pipe screwed into a cap comprised the pot. The handle was made of two pieces of ½-in. rod threaded into the pot and held at their outer

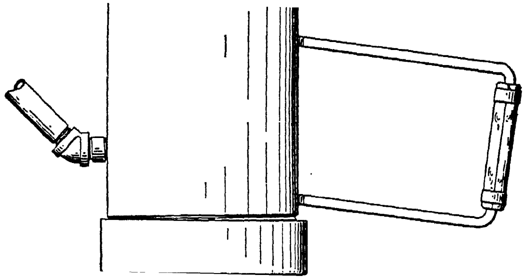


FIG. 310.—Pipe-fitting babbitt pot.

ends by a two-piece wood handle clamped in place. A nipple to connect a 45-deg. elbow to the side of the pot and a length of pipe comprised the spout. The pipe should be long enough to extend up to the top of the pot.

This pot keeps back the dross on top when babbitt is being poured. Also, bearings can be poured that are not easily reached with the ordinary ladle. A straight handle can be used.

Toronto, Ont. JOHN JAMES.

961. An Improved Babbitt Melting and Pouring Pot.

The body and spout are made from $\frac{1}{16}$-in. black sheet steel, and the parts are welded together. The small diagram on the right of Fig. 311 shows the pot body before the spout was welded in position.

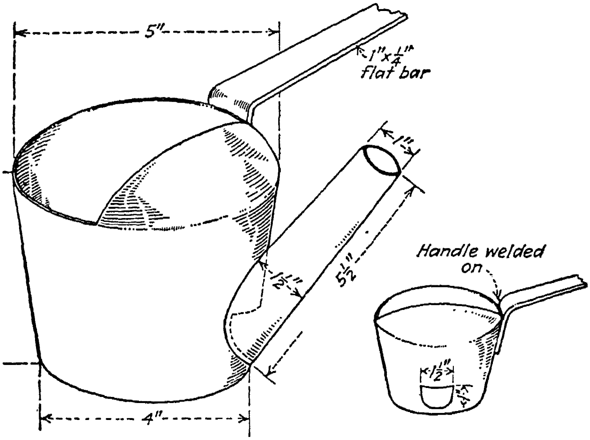


FIG. 311.—Improved babbitt-pouring pot.

The hole in the pot body is semicircular, as it is found in babbitting practice that a semicircular hole of a suitable size gives better results than a round hole. It keeps impurities or dross from entering the bearing, and the pot gives a clear flow of molten babbitt from the bottom.

Manchester, England. A. EYLES.

962. Sliding Handle for Babbitt Ladle.

A convenient auxiliary handle that can be fitted to any babbitt ladle is made from a short length of wooden bar such as a piece of broom handle, drilled through for a piece of heavy wire or ¼-in. round rod which is bent around the ladle handle (Fig. 312), so that it is loose enough to slide up and down readily. With this attachment, the user always has a cool handle near the hot metal. Of course, it is slid back when the babbitt is being melted.

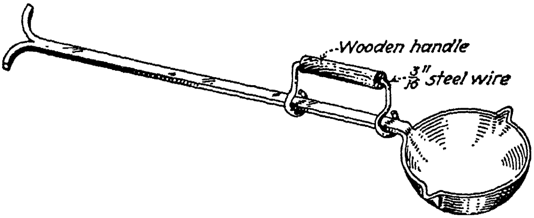


FIG. 312.—Sliding auxiliary handle for babbitt ladle.

Such a handle, being above the surface of the metal, prevents splashing on the operator's hand as the ladle is carried to the job.

Hamilton, Ont. H. MOORE.

963. Bearing Scraper with Renewable Blades.

The type of bearing scraper shown in Fig. 313 has many advantages over the conventional half-round tool. Pressure can be regulated with both hands from opposite sides of the bushing or bearing. In this way, not only can greater speed be attained, but the high spots can be removed without coming in contact with an existing low spot.

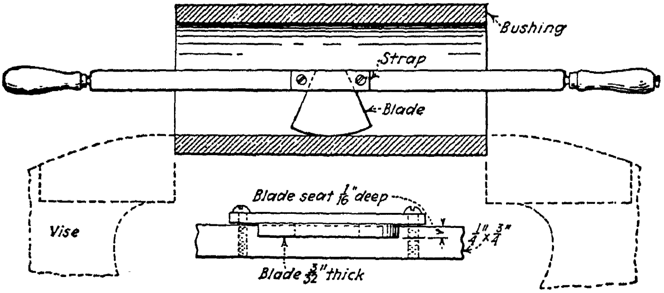

Bushing
Strap
Blade
Vise
Blade seat $\frac{1}{16}$" deep
$\frac{1}{4}$" x $\frac{3}{4}$"
Blade $\frac{3}{32}$" thick

FIG. 313.—Scraper handle extends through bushing.

It is made from a piece of cold-rolled steel ¼ by ½ in. and 10 to 12 in. long. The bar is pointed at both ends to form a tang, to which file handles are fitted. At the center an angular seat is milled or filed to take the cutter. The seat should be about 1/16 in. deep. The angular-shaped cutter is made of tool steel about 3/32 in. thick, properly tempered. It is made to conform with the corresponding seat in the holder. A strap secured by two machine screws holds the blade in place.

Syracuse, N. Y. H. L. WHEELER.

CHAPTER XIX

MISCELLANEOUS

964. Five- and Six-day Week Schedules for Power-plant Operators.

The six-day week plan provides for one extra man for each six men employed. Where six men work at the same job it is not difficult to work out a schedule, but where three men work on one job and three on another it is not so easy. The following schedules have been worked out to show possible combinations:

Schedule 1

First Week

Shifts	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	A D	X D	X D	X D	C X	C X	C X
2	B E	B E	A E	A E	A E	A D	A D
3	C F	C F	C F	B F	B F	B F	B F
				Second Week			
1	C F	C(X)F	X F	X F	X F	B X	B X
2	A D	A D	A D	C D	C D	C D	C F
3	B E	B E	B E	B E	A E	A E	A E
				Third Week			
1	B X	B E	B(X)E	X E	X E	X E	A X
2	C F	C F	C F	C F	B F	B F	B F
3	A D	A D	A D	A D	A D	C D	C D

Schedule 1 gives every man six days a week. The shift men have one Sunday off in eight; and the relief men, two Sundays off in eight. The main objection to this schedule is that it is necessary to work the relief man on some other job one day a week six weeks out of eight. Another objection is that each man works eight days straight before he has a day off even though he works but six days in any one calendar week.

Schedule 2
First Week

Shifts	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	A D	X D	X D	X D	C X	C X	C X
2	B E	B E	A E	A E	A E	A D	A D
3	C F	C F	B F	B F	B F	B F	B E

This schedule is simplest. The relief man works steady days and no Sundays. The main objections to it are that each man has a choice of only three different days off a week, works every Sunday, works the day shift only four days in three weeks, and must work seven straight days without a day off. This schedule can be used where A B C and D E F work at different jobs and receive different rates. It is probably the only satisfactory schedule for such a condition.

Schedule 3
First Week

Shifts	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	A D	X D	A X	A D	A D	A D	A D
2	B E	B E	B E	X E	B X	B E	B E
3	C F	C F	C F	C F	C F	X F	C X

Second Week

1	B E	D E	B F	B E	B E	B E	B E
2	C X	C X	C X	F X	C F	C X	C X
3	A D	A D	A D	A D	A D	A F	F D

This schedule has worked rather satisfactorily for men at the same job and getting the same rate. It cannot be used for men on two different jobs getting different rates. Although each man gets the same "break" over a period of seven weeks, there are many objections to this schedule. The relief man must change shifts twice in one week every eight weeks, and once in eight weeks he must work 11 days straight without a day off. However, it has been found that this schedule is more satisfactory than any of the others suggested.

SCHEDULE 4

First Week

Shifts	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	A D	A D	A D	A D	A D	X D	A X
2	B E	B E	B E	X E	B X	B E	B E
3	C F	X F	C X	C F	C F	C F	C F

This schedule is similar to No. 3 except that the relief man works backward the same shifts all the time. Monday and Tuesday he works 12 to 8; Wednesday and Thursday, 4 to 12; and Friday and Saturday, 8 to 4. The objection is that he has only two 8-hr. rests between shifts twice a week. It is not certain that a man could stand this frequent changing without sufficient rest between changes. The shift men work all the Sundays but only six days a week.

SCHEDULE 5

Shifts	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	A D	X D	A X	A D	A D	A D	A D
2	B E	B E	B E	X E	B X	B E	B E
3	C F	C F	C F	C F	C F	X F	C X

This schedule is also similar to No. 3, except that the relief man shifts forward. He has 24 hr. off between changes. The shift men work all the Sundays and work eight days straight without a day off.

Even though the foregoing schedules provide means for working men only six days in any one week, they are not ideal. It is difficult to arrange a schedule in which every one will share alike.

With the present unemployment situation it would appear that the next step toward shorter hours per week and more men employed is the five-day week. A five-day week for eight-day operation requires one extra man for each three men employed. The following schedule may be used for a five-day week:

Schedule for Five-day Week
First Week

Shifts	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	A	A	A	A	A	A	X
2	C	C	B	B	B	B	B
3	X	X	X	X	C	C	C
Second Week							
1	X	X	X	X	X	C	C
2	B	A	A	A	A	A	A
3	C	C	C	B	B	B	B
Third Week							
1	C	C	C	C	B	B	B
2	X	X	X	X	X	C	C
3	B	B	A	A	A	A	A

Although the foregoing schedule is not strictly a five-day week, since each man works six days a week twice in eight weeks, it approaches a five-day week and does not have any of the objections of the six-day week schedules. Each man gets the same number of days off, with one Sunday off in four weeks. He works on an average of 5½ days a week and, if paid time and half for Sundays, receives pay for 5⅝ days a week.

Parlin, N. J. G. L. E. Linn.

965. Painted Marker Shows When to Turn on Lights.

One of the operator's duties at our station is to energize a portion of the city's street-light circuits and to notify other substations to turn on the balance of the street lighting. This operation is performed at a certain degree of darkness rather than according to any astronomical schedule. As the installation of a photoelectric alarm or control would have been rather expensive, a simple means was devised to determine the exact time at which the street lights should be turned on.

Across the alley from the station is a barn the wall of which can be seen from the engine room through a window. An area about 18 in. square on the wall of the barn was painted black, with the exception of a 6-in. diameter circle in the center of the square. This center was painted dark green (Fig. 314).

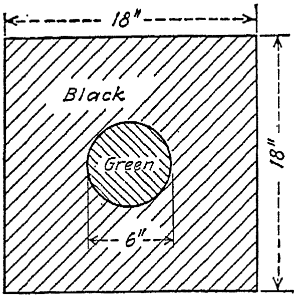


Fig. 314.—Painted marker shows when to turn on lights.

A street-light system following the astronomical schedule should go on at 15 min. after sundown. We experimented with our painted marker on clear days and adjusted the shade of green in the center portion so that at about 10 min. after sundown, it was not possible to distinguish the circle in the square, because the two dark colors blended in the dusk. This gives the operator 5 min. to call the other substations and notify them of the time to close circuit switches.

The device will work for any kind of a day, cloudy or clear, as the blending of the colors depends entirely upon the outdoor illumination. It was discovered also that the artificial lighting in the engine room did not interfere with the indication from the marker.

Topeka, Kan. O. K. Johnson.

966. Repairing Concrete.

Repairs may be made easily to an unsightly hole in a concrete floor or to a corner knocked from an engine foundation, but something more is required than merely to apply a dab of concrete or cement mortar and finish it smoothly to match its surroundings.

Such a repair will last but a short time, when the applied concrete will become loose and fall from place. New concrete will not bond with the old. In order to secure a good tie between old concrete and new, three requirements must be fully met.

There must be no loose or adhering bits of concrete. There must be no grease upon the surface to be repaired. There must be no weathering of the old concrete; the particles must be clean and free from carbonization or other atmospheric effects.

In order to meet all these conditions fully, first brush the surface thoroughly. Use a stiff fiber or wire brush and, with an awl or some sharp-pointed instrument, carefully search out and remove any little pieces of old concrete that may have spalled off. Then give attention to cleanliness of the surface. Never touch the surface with the fingers after it has been made clean by using lye in water. Make the mixture so strong that it makes the fingers sore; this is about 104° by a hydrometer, or, as the old-time soapmakers used to say, the solution will float an egg.

With a clean fiber scrubbing brush, apply the solution to the surface to be repaired, scrubbing it patiently and thoroughly until every trace of oil and grease has been removed. Next, wash off the lye with many flushings of clean water. In a wooden or earthern vessel, mix muriatic acid with water until a bit of old concrete placed in the solution will show a faint boiling effect, which means that the acid is attacking the concrete. Do not make the acid solution strong enough to boil vigorously when it comes in contact with the concrete. With the acid solution and a fiber brush, scrub the concrete surface thoroughly until the weathered concrete has been dissolved by the acid, and an entirely new surface has been exposed.

Next, wash off all the acid; not a particle must be left on the concrete, or the new concrete will separate from the old. Do not let the surface become dry before applying the new concrete. Better plan the concrete mixing so that the mixture will be ready as the final washing has been completed.

Indianapolis, Ind. James F. Hobart.

967. Oil-resistant Floors.

The labor required for repairing old floors or installing new floors costs no more for a floor that will be resistant to oil than for a porous floor which soaks up oil and disintegrates rapidly.

There are preparations on the market which can be incorporated in the cement topping at a cost of less than 1½ cts. per square foot for a 1-in. topping. These integral floor hardeners produce a good bond between the new topping, or patch, and the underlying concrete. They harden and waterproof the cement topping in one operation, producing high early strength so that the repair work or new work may be installed over the week end and the floors used Monday morning.

New York, N. Y. M. W. Meyer.

968. Storing Machinery.

Polished surfaces, such as the journals of any machine which is to be in storage or transit for a considerable period, should be carefully coated or slushed with a good grade of rust-preventive compound, preferably the heavy grade which sticks well and stands high climatic temperatures without running off the surfaces. The presence of lubricating oil in the bearing wells or the lubricating system is not a positive insurance against corrosion when a machine is idle for a long period. An idle machine should be jacked over and the oil circulated at least once a week. If a machine is to be laid up for an indefinite but long period, the journals and other parts susceptible to corrosion should be coated with a good rust-preventive compound. Furthermore, these parts should be inspected once every six months and preferably every three months.

Annapolis, Md. T. A. Solberg,
Lieutenant Commander, U.S.N.

969. "Bedding" Machinery.

There is a method of bedding heavy machinery which can often with great advantage take the place of grouting. The plan is to go over the concrete bed with steel picks to remove all soft and loose material, and then it is washed clean. Bedplates are placed in position and leveled up on shims and wedges, leaving a space of from ¾ to 1 in. for the cement filling.

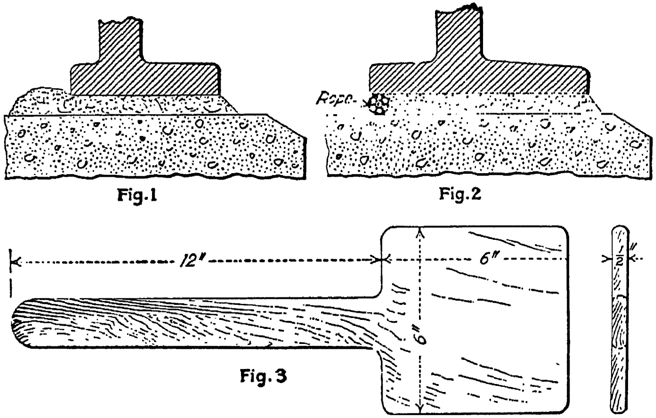


Fig. 1 Fig. 2 Fig. 3

Fig. 315.—Method of bedding machinery and paddle used for ramming.

Cement composed of two parts of well-washed sand and one part of cement is made, and only enough water used as to make a good stiff mix, so that when made into a ball, it retains its form. If the top of the foundation has dried out, wet it again.

The cement is pushed in to a depth a little greater than the depth of the bedplate bearing, as shown in Fig. 315-1. This forms a barrier against which the rest of the cement is packed. One man goes around forming the barrier, and another man follows to complete the filling. By the time the space is filled, the cement is ready for ramming with a wide and thick paddle or ramming tool. When the cement has been well rammed, it is ready for trimming and finishing. There will be no shrinkage and no voids.

A barrier can sometimes be made by driving in a piece of rope as in Fig. 315-2. Figure 315-3 shows the kind of wood paddle used to push in the cement.

Long Beach, Calif. J. JORDAN.

970. Trisodium Phosphate as a Cleaner for Equipment Parts.

Cleaning small pumps, burner tips, and other parts of equipment coated with dried or burnt grease or oil always has been a tedious and more or less futile job with us. This year we dismantled our three return pumps on the heating system for inspection and repair, and they were very dirty.

We used a watertight barrel with a small steam pipe connected to it for heating. Then all of the parts of one pump were put into the barrel, after which it was two-thirds filled with water and a gallon of trisodium phosphate. A little steam was then turned on. After an all-night treatment in this solution the cleaning was complete.

Anderson, Ind. GEORGE S. BILLMAN.

971. Cleaning Metal Parts with Acid.

Some time ago, our injector refused to work. When I took off the cap at the bottom and lifted out the combining tube, I found that it was almost completely filled with a sediment like soft lime. There was also considerable scale in the draft tube and in the suction chamber. I tried boiling it in hot soda water, but that would not remove it. So I diluted some muriatic acid by adding 10 parts of water to 1 part of acid and put the injector in the solution for about 2 hr. When I took it out, the metal was clean.

Hamilton, Ont. IRA S. ELLIOTT.

972. Protecting Fan Shafts from Corrosion.

Fans that have to handle hot and corrosive gases often give trouble at the bearings. This is partly due to corrosion and partly to lubrication difficulties.

Chromium plating that part of the shaft in actual contact with the bearing will insure against seizures and burnouts. It gives a hard surface that is not easily scored or worn off. Chromium runs well on white metal, being much less dependent on lubrication than a steel shaft. It also makes the bearing surface resistant to corrosion and pitting by acids.

Brighton, England. W. E. WARNER.

973. Parallel Operation of Fans.

Only fans with rising pressure characteristics should be used for parallel operation. A fan is of rising pressure characteristic type when the pressure curve rises continuously from free-delivery to no-delivery condition. If two or more fans discharge into the same duct, the connections from the fan discharge to the duct should be designed so that the frictional loss in each case between the fan discharge and the duct will be equal.

974. Simple Hoist Used to Handle Transformer Parts.

A simple but adequate hoist for economically handling bushings and radiators during transformer assembly is shown in place on a 15,000-kva. self-cooled transformer (Fig. 316-1). The vertical member (Fig. 316-2) is an 11-ft. length of 4-in. extra-heavy pipe mounted in a socket consisting of a short length of 5-in. extra-heavy pipe welded to a ⅝-in. heel plate. At an elevation of 7 ft. 6 in. above the transformer cover, a 6-in. 12.5-lb. I beam 7 ft. long is slung in a horizontal position. The I beam is connected to the upright member by a collar made up of structural pieces welded and bolted together. A chain-block traveler and a 1-ton chain block are installed on the I beam.

The hoist is secured to a timber base which is mounted on and bolted to the transformer cover, through the cover bolt holes. The base mounting is arranged to clear manhole and bushing covers.

Baltimore, Md. B. Van Ness,
Pennsylvania Water and Power Co.

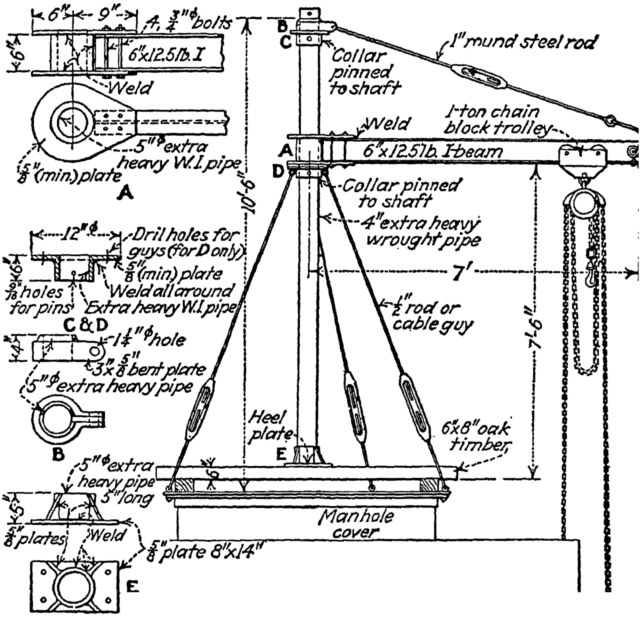


Fig. 316.—Parts and assembly of hoist.

975. "Dry Ice" Lowers Large Tank to Its Foundation.

An interesting method for placing heavy equipment has been used successfully by the engineer of a large ice-cream plant. The problem was to spot a 20 by 13 by 5-ft. rectangular welded-steel brine tank, weighing 6,500 lb., on a flat foundation. The tank was fabricated on wooden cribbing placed so that all parts of the tank were accessible for welding.

After welding, six blocks of dry ice (solid carbon dioxide), each 10 by 10 by 10 in., were evenly spaced on the foundation. The tank was moved approximately into place and lowered by jacks until it rested directly on the dry ice. Friction between the tank bottom and the dry ice was so small that the former could be moved into position by one man pushing against it. After being positioned, the tank was then blocked to prevent shifting and allowed to settle to its final position as the ice melted away. Dry ice evaporates to a harmless gas, so that no trace of it remained under the tank.

It took about 5 hr. for the ice to melt, but the melting can be accelerated or retarded by heating or insulating the blocks of ice as the structure settles.

The method is believed to be applicable to lowering all kinds of heavy equipment where the space is cramped and where overhead crane facilities cannot be had.

New York, N. Y. C. L. Jones,
American Dry Ice Corp.

976. Simple Formulas for Tank Capacity.

I should like to submit the following formulas, any one of which is easy to apply and to remember, especially Nos. 2 and 3:

Formula (1): $D^2 \times 0.4896$ = U. S. gallons per 1 in. of height. (D in feet)

Formula (2): $D^2 \times 5\frac{7}{8}$ = U. S. gallons per 1 ft. of height. (D in feet)

Formula (3): $D^2 \times 0.0034$ = U. S. gallons per 1 in. of height. (D in inches)

Formula (4): $D^2 \times 0.0408$ = U. S. gallons per 1 ft. of height. (D in inches)

The measurement D represents the diameter of a round tank resting on its circular base.

As to memorizing the factors, I should suggest remembering the factors $5\frac{7}{8}$, or 0.0034. The latter factor can easily be remembered by using the principle of "mnemonics." Count the zeros at the right-hand side of the decimal point and then continue thus:

.0	0	3	4
One	Two	Three	Four

Just remember 1, 2, 3, 4, and the rest comes to your mind without difficulty.

Peekskill, N. Y. E. Bunzel.

977. Steam Heater for Exposed Tanks.

Figure 317 shows an inexpensive heater for exposed tanks of liquids subject to freezing in extreme weather. A piece of pipe two sizes larger than the riser is welded to the riser, forming a steam chamber around it. If the riser is already installed, the larger pipe will have to be in two segments, and additional side welding applied.

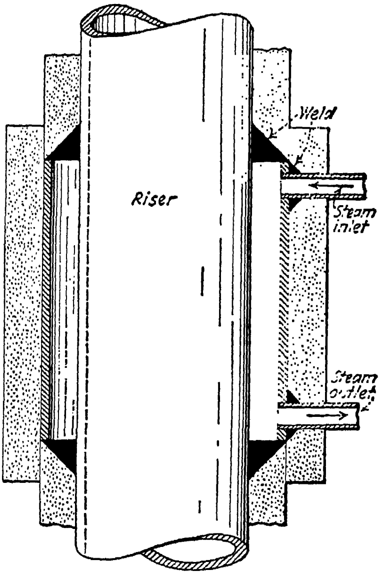


FIG. 317.—Steam chamber around riser keeps water above freezing.

This heater should be well insulated and placed as close to the tank as practicable and should be of such size as to heat the water sufficiently to keep it from freezing only. If the heater is made too large, excessive expansion may be set up, and, unless adequate provision for expansion is provided, damage may result. When figuring the size of the heater, it is essential that the tank material be considered, as an error there will result in an ineffective heater.

Brooklyn, N. Y. WILLIAM ANDERSON.

978. Locating Vacuum Leaks with Oil of Peppermint.

A method I have used for some time, which does not seem to be generally known, is that of applying oil of peppermint at possible sources of leakage in a vacuum system. The oil is applied by pouring a small amount along the joint to be tested or by saturating a cloth with the oil and wrapping this cloth around the joint. If there is a leak, the peppermint odor will quickly pass through the system and may be detected almost instantly by an assistant stationed near the atmospheric discharge of the air-removal apparatus. A short time interval should be allowed between applications at various points, to allow the fumes to pass through the system, if there is leakage, and the assistant to signal the condition after each test. This method is reliable in testing for leakage through the low-pressure gland packing on turbines using water for low-pressure sealing.

Shreveport, La.

M. S. FITZWILLIAM,
Chief Engineer, Arsenal Hill Station,
Southwestern Gas and Electric Co.

979. Soot Removal from Chimney by Water Jets.

I have found the method shown in Fig. 318 simple and effective. Anchor a water line to the stack just above the cleanout door. Two nipples pointing down and tilting inward are teed off of the horizontal line, which is of 1-in. pipe. A wooden trough 4 by 10 in. in cross-section slopes away from under the cleanout door to lowland. At cleaning time, water is turned on, and it mixes with the soot, the mixture flowing down the trough.

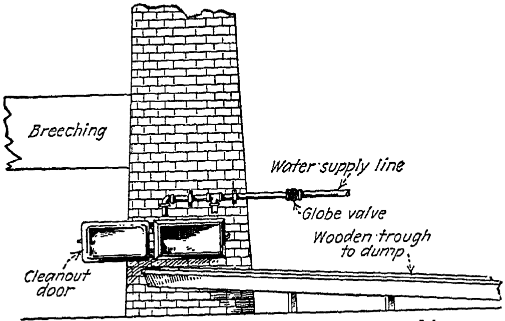


FIG. 318.—Water jets flush out soot from chimney.

Philadelphia, Pa.

M. O. ROSS.

980-982. Three Odd Uses of the Indicator.

980. The steam-engine indicator sometimes is useful in other ways than indicating a steam engine—at least, we have found it so. We attached it to the steam drum of a battery of boilers once in an effort to find out why the pulsation of the steam pipe was so great. We did not get so much information as we had hoped, for the variation in pressure was too slight. However, we did demonstrate that the risers from the boilers were ample in size; at least, we could not detect any difference in pressure between the boiler and the end of the riser.

981. The company installed some wet sandblast machinery which did not give satisfactory service, so we attached the indicator just behind the blast guns and, by pulling the drum cord by hand, got diagrams that indicated that the steam piping was too small.

982. Lately, the master mechanic designed a machine on which there was a 3-in. air cylinder, the air being admitted and exhausted by a hand-operated slide valve. The cylinder was designed for ample power, but it would not do the work when put into service. Upon connecting the indicator, we found that the initial pressure was 65 lb. and the back pressure 40 lb. A few changes in the valve gave all the power needed.

In pressure problems, the engineer should not forget the pressure gage and the indicator. Many times we get all fussed up looking for trouble in a pump or other pressure apparatus when a gage would tell us at once where the difficulty was.

Anderson, Ind. J. O. Benefiel.

983. Another Use for the Indicator.

The recording-pressure chart from the discharge of a large exhauster showed a wide variation in pressure. The record was more of a ribbon than a line, but it was impossible to distinguish any definite separation between the up-and-down movements.

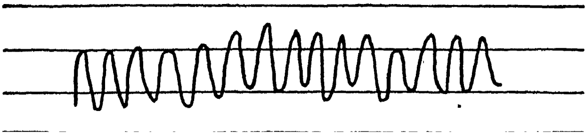


Fig. 319.—Facsimile of indicator diagram.

In order to record the actual pulsations of the exhauster, to obtain the character and range, it was decided to use an indicator with a special spring for the range of pressure in the line. This pressure was about 3 lb. average, so that a 2- and a 4-lb. spring were used.

The demarcation was surprising, the motion of the pen being distinct and easily readable. By means of the proper scale, we were able to get the extent of the pulsations. We were not interested in the time of the pulsations, as this could be obtained from the speed of the exhauster. It would have been hard to time the paper speed. As it was, we simply put the indicator on the gas line and moved the paper by hand at the desired speed, obtaining a clear, sharp diagram, as in Fig. 319, which corresponded to the actual chart record.

Dayton, Ohio. C. W. STEVENS.

984. Making a Spongy Ferrous Casting Tight with Sal Ammoniac and Oxygen.

We had a hurry-up order for a 12-in. valve to stand a hydrostatic test of 1,500 lb. Upon putting a valve under test, when 900 lb. pressure was reached, the fillet adjacent to the bolt flange at one end leaked little streams of spray, and great drops of water from the smaller interstices which formed would unite and start little rivulets.

Electric welding a smooth cylindrical surface 42 in. long and 2 to 3 in. wide and leaving it smooth seemed an impracticable and precarious undertaking, and as the time to get it ready for shipment was short, the valve body, which had been machined, was filled with a saturated solution of sal ammoniac, and oxygen from a welding tank was permitted to flow through the solution till 1,500 lb. pressure was reached.

It was left overnight or until the exuding liquid, judging from the taste, had permeated every pore of the steel and formed ammonia salts on the outer surface of the valve. When the level of the liquid was lowered till oxygen alone permeated the spongy parts, completely oxidizing its path, the casting was found bottle-tight, and it is today carrying 1,000 lb. pressure at 800° superheat.

Orrville, Ohio. C. E. SARGEN.

985. Heavy Wire Clamp Connects Hose to Couplings.

Instead of using the regular type of clamps on hose couplings, our machine shop has adopted a heavy wire type that will hold against 100 lb. per square inch. The wire clamp is drawn so tightly by a simple tool that it sinks into the rubber and leaves practically a smooth surface.

Figure 320 shows the tool for putting on the clamp and how the clamp is applied. Head *D* of the tool is about ¾ in. long by ¾ in.

wide and ½ in. thick at the screw. Its front end is tapered to about ¼ in. thick, with a groove to hold the wire. The tension screw can be made from an old valve stem on a piece of ⅝-in. round steel, and the handwheel *K* can also be from an old valve. Block *M* for tightening the wire is about 1½ in. long by 1 in. wide and ½ in. thick, tapped for ¼-in. setscrews. The holes for the wires are about ⅛ in. in diameter.

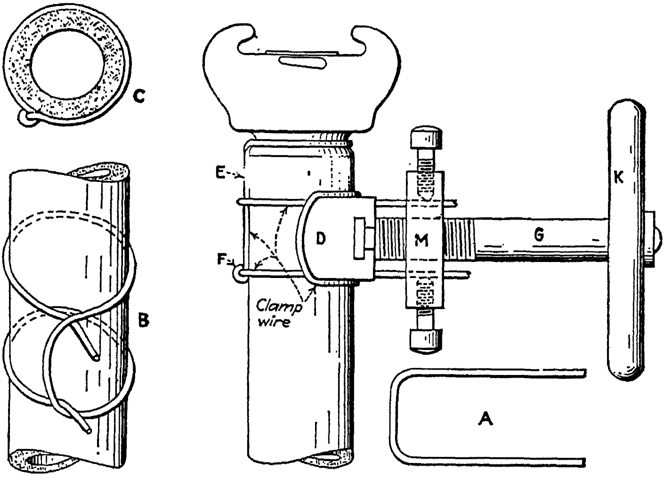


FIG. 320.—Hose clamping tool.

To clamp a connector, first take a length of soft iron wire of sufficient length to go around the connector's neck and leave ends about 2 in. long. Place the connector in the hose and bend the wire back over the hose as at *E*.

Next, take another piece of wire long enough to go around the hose three or four times and bend it into the shape shown at *A*. Lay the wire against the hose and bend it to form loops as at *B* and place the loops near the end of the hose over the connector. Insert the two ends of the wire into the holding block *M* and fit the loop of the wire into the head *D*. Tighten the setscrew to hold the wire ends in block *M* and tighten the wire around the hose by turning the handwheel.

When the wire is sufficiently tight, rotate the tool around the hose to bend the ends of the wire around the connection between the two loops. This will form hooks to prevent the clamp from coming loose when the setscrews are loosened and the tool removed. The ends of the wire are now cut off and hammered down, and wire from the connector is looped around the clamp as at *F*. Wire *E* prevents the connector from being pulled out of the hose.

Rockland, Mass. BURTON W. WHEELER.

986. Weighing Ashes.

I recall an ingenious device applied by an engineer for International Harvester Co. to an ash skip hoist at its Chicago plant. This device consisted of a mechanical counter, which was actuated by a lever terminating in a roller having contact with the hoist rope as it left the drum. Its operation was based on the amount of rope travel across the face of the grooved drum which took place during a single complete hoist cycle of the skip bucket. The roller touched the hoist cable only at one end of this travel; consequently, it was actuated only once for each load of ashes handled by the skip bucket. The counter, being in effect an adding machine, recorded the total number of bucket loads that were handled, no summation being necessary.

This device was applied primarily to permit ash-handling labor to be paid by piecework. Incidental advantages have been gained in giving accurate information as to the cost per ton of ash handled, the life of hoisting cable, and other similar records.

Various modifications of this same idea have been applied successfully to both full-automatic and semiautomatic skip hoists handling coal, coke, ashes, and other bulk materials.

Chicago, Ill. C. C. PLUMMER.

987. Long-distance Measurements of Fuel Unloaded or Ashes Removed.

I have frequently found it useful to know just how many loads of ashes were removed each day by the hoist or how many buckets of coal went to the boilers or how many buckets were removed from the coal pile, etc. Of course, the amounts handled are converted into tons, so that accurate records may be kept.

A method used by us was the employment of multiple-pen electric time recorders. The pens on the chart are actuated by small magnets, one for each pen, and these in turn are energized through limit switches or contactors located on the moving equipment. Each cycle is indicated by a mark on the chart.

We found that excellent results could be obtained by mounting the contact switches on the drums on the hoists, so that the rotation of the drum would throw the switch in the desired position. The instruments were mounted on the boiler-house gage board, visible to the operators.

Each day, when the charts were brought in, the total consumption of coal, coke, etc., was calculated by multiplying the number of trips of the buckets by the capacities of each. Otherwise, it is difficult to obtain these figures, as the hoist operators are taxed with their operation, and it is impractical to have a man specially to check the coal unloaded. With regular freight-car unloading, where records travel with the cars, and the units are so large, the tonnage can easily be watched; but where one desires the amount to any particular service or hopper, this is a practical way of recording it.

Pittsburgh, Pa. F. M. AHER.

988. Steam-jet Vacuum Cleaner for Power Plants.

A good vacuum cleaner is useful for removing the dust from boiler tops, overhead walkways, steam pipes, and roof girders without distributing dirt all over the plant. With a rubber nozzle attached to the suction hose, dust can be removed from moderate-voltage bus bars and switch gear while alive. Soot and cinders can be removed from the cracks between sectional water-tube boiler headers and around the setting, a job which cannot be performed satisfactorily with any other tool. Clogged cinder chutes can be opened by slowly feeding a small suction hose into

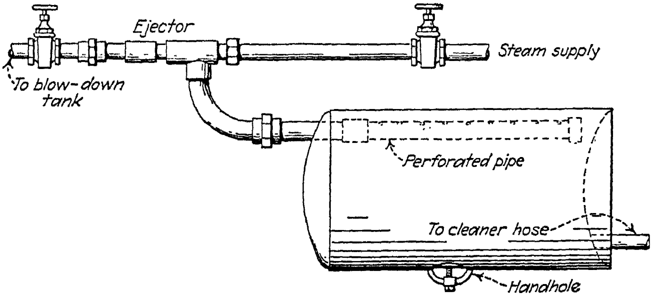


FIG. 321.—Steam-jet vacuum-cleaner system.

the cinders and gradually removing them, instead of packing them tighter, as frequently occurs when a water hose is used.

A vacuum cleaner for this purpose can be purchased, but when the money is not available, a suitable cleaner may be constructed with a small dirt-collecting tank and a 1½- or 2-in. steam ejector, as in Fig. 321. The discharge from the ejector may be turned into the boiler blowdown tank, which is usually provided in power plants.

If more than one hose connection is necessary, it is desirable to purchase regular vacuum-cleaner connections, as they are provided with spring covers which automatically close the outlets not in use. Also, it is desirable to purchase regular vacuum-cleaner hose, preferably protected with woven-steel bands, as it will give much more service when dragged over concrete floors.

A floor tool, handle, and hose connection are necessary. A bristle-brush floor tool gives good results, although when the vacuum is limited a small carpet tool will remove the dust more rapidly. A round hairbrush is handy for dusting pipes and girders, and with a tapered rubber nozzle all the necessary tools will be provided.

In piping the cleaner, unions should be provided so that the steam siphon can be removed for cleaning, while bends should be made with long-radius drainage fittings, bent pipe, or conduit elbows.

Altoona, Pa. A. R. MARKLAND.

989. Steam-jet Vacuum-cleaner Repair.

Trouble was caused by the dust and sharp coal particles' gradually eroding and cutting away the side of the steam-jet casting, where they impinged owing to their high velocity. It was decided to install a hardened-steel wearing plate where the erosion occurred.

A piece of ¼- by 1-in. strap iron was bent in a U shape and welded on the two sides of the elbow, as in Fig. 322. The section of the elbow subjected to erosion was cut away with an acetylene torch. The cut edges were then ground smooth and straight. A piece of hardened manganese steel was obtained ½-in. thick and of dimensions to cover this opening. A 9/16-in. hole was drilled through the U-shaped strap, and a ½-in. nut was welded over this hole, which came over the center of the wearing plate. When the wearing plate was in position, it was held there by a bolt threaded into the nut.

Milford, N. J. HARRY M. SPRING.

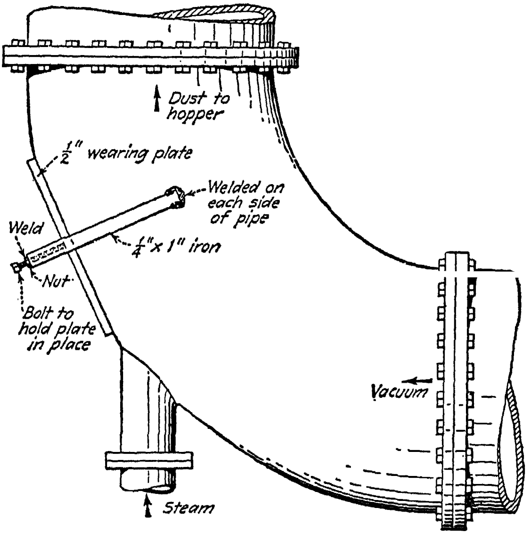


FIG. 322.—Built-on wearing plate withstands erosion.

990. Cutting and Welding Torch an Important Power-plant Tool.

I installed two 60-in. by 18-ft. boilers for a heating system. The heating mains were carried through an underground tunnel 520 ft. in length, and all piping that was used had been salvaged from another tunnel after eighteen years of use. Some of this pipe was pitted badly, and these places were built up with the torch. The ends were cut off, and the lengths of pipe were welded together. The pipe varied in size from 1½ to 6 in., and no fittings were used except at the reducing valves and expansion joints.

This method of fitting is much faster and costs less than threaded joints and is less likely to leak when the steam is turned on. To weld seven joints of 6-in. pipe, about 100 cu. ft. of acetylene is required, 2½ lb. of filler rod, and from 25 to 35 min. to each joint. Branches are readily taken care of by cutting a hole in the pipe and welding in a short nipple without taking down the line. A 2-in. hole can be cut out, and a nipple welded in place in less than 1 hr.

I find the torch handy for heating rivets when erecting steel I beams and supports. We put the rivets in place, then heat them to the right glow with the torch in just a few seconds. In pipe bending, up to 2 in. in diameter, you can get the heat just where you want it with the torch, and it is surprising how easily the bending can be done. In refrigeration work, it is one of the best means of pipe fitting I know of, as it does away with nearly all flanges and fittings and reduces the chances of leakage from bad gaskets or poor threads.

To appreciate the advantage of welding, one has only to be given the job of installing a set of ammonia condensers where the space is limited. By using the torch, you can place the suction header where you want it, cut out the holes to fit each stand of condensers, and weld them in place.

Sioux Falls, S. D. EMILE J. TURGEON.

991-993. Three Hints for Doing Welding Jobs.

991. Bronze welding is essentially a brazing process and is not to be confused with a fusion weld. In the former, the base material is at no time in the molten state. The joint is made by the adherence of the spelter, or brazing alloy, to the base metal, which is assisted by using the proper flux, usually a compound of borax. In this process, the base material is heated to a dull red, and the flux and weld material applied. If the work is at the correct temperature, the metal from the rod will immediately spread out into a thin film over the base metal; but if the base metal is too hot or in a molten state the rod material will not flow.

992. Fusion welding of copper is difficult, unless deoxidized copper is used. Commercial or electrolytic copper contains cuprous oxide, which makes the metal weak and brittle. Molten copper absorbs oxygen rapidly, resulting in a bad weld that probably will fracture in cooling or handling. Welding with deoxidized copper is the same as welding steel except that a larger tip is used on the welding torch, and it is advisable to preheat and cover work with asbestos.

993. Bronze welding for cast iron has many advantages over a regular fusion weld using an iron filler rod. This method precludes the necessity for preheating and reheating, and with moderate care the most intricate castings may be readily welded. Any heating may be done with the welding torch or a kerosene torch, and the weld made in thin layers, each of which should be thoroughly peened before the weld metal has cooled. This peening will remove the stresses produced by cooling and contraction.

Arlington, Mass. ELLIOTT MACDERMOND,
Inspector,
Hartford Steam Boiler Inspection and Insurance Co.

994-996. Three Pointers on Using Silver Solders.

Silver solder is extensively employed for joining metal parts when greater strength is required than can be obtained by ordinary soldering or when the high temperature of welding methods may affect parts adjacent to those being joined. Brass, bronze, copper, nickel, and monel-metal power-plant equipment can be repaired so effectively by brazing with silver solder that the brazed joint will be approximately as strong as the metal itself. Many power-plant engineers associate high cost with silver solders. However, because of their free flowing properties and the fact that joints require little finishing, these solders are economical to use.

994. Too much care cannot be taken in preparing the metal parts to be repaired or joined. Although a good flux will dissolve films of oxide during the brazing operation, it is essential to start with perfectly clean surfaces. Various methods of cleaning may be employed, such as filing, scraping, or grinding. If the parts are greasy, they should be immersed in a hot alkali solution to remove all trace of grease or oil. The parts should be held together firmly while the brazing operation is being performed. Silver solder is remarkably fluid when in a molten state and penetrates interstices which ordinary brazing spelter would fail to fill. Only a film is necessary to form a strong joint. It is wasteful to use the solder as a filling-in material.

995. In order to protect the metal surfaces against oxidation and to assist in the free flowing of the silver solder, a flux is essential. Experience has shown that either calcined (fused) borax or a mixture of borax and boric acid will give good results. However, the borax is generally more satisfactory when used in the following ways: (1) Dissolve it in clean hot water to make a saturated solution. (2) Mix calcined borax with alcohol. This flux should be kept in a closed container to prevent evaporation when not in use. The saturated borax solution should be kept hot while using, as the borax is then more evenly deposited.

996. Great care should be taken not to overheat the metal parts with the torch flame during the brazing operation. When sufficient preheat has been applied to the joint, the flame should be moved away, and the silver solder brought to the joint, where it will melt and flow quickly if the parts have been properly cleaned, fluxed, and preheated. The heat should be continued only long enough to cause the solder to flow freely. Prolonged heating with the torch flame tends to oxidize and weaken the solder and the base metal. As soon as the brazed joint is completed, immerse the piece in cold water. This will disintegrate the flux. If the brazed joint is allowed to cool slowly, the flux usually sets into a hard, vitreous film difficult to remove. A little sulphuric acid added to the water used for quenching greatly assists removal of flux and scale.

Manchester, England. A. EYLES.

997-999. Three Babbitting Tips.

Instead of covering the arbor, or journal, of the shaft with paper, preheating, or covering with a clay wash, I have found it much better to smoke the journals or mandrels with kerosene.

997. A kerosene-soaked rag put down in a piece of pipe about 1 or 1¼ in. in diameter, when lighted, will burn with a soot-depositing flame. Small mandrels, or shafts, may be held over the flame and rotated by hand, thus becoming coated thinly and evenly with a smooth carbon deposit which is practically a nonconductor of heat.

998. Babbitt metal, when poured over this smoked journal, is found to have a smooth and shining surface with almost no blowholes. If the deposit has been made the right thickness, which can readily be learned by experience, no scraping or fitting is necessary.

999. I have used this method in cases where it was desired to babbitt a solid bearing or to cast a nut bearing over a threaded screw. Of course, the carbon must be deposited somewhat thicker than in the case of a split bearing, and it is found easy to start the screw loose in the newly poured nut.

Rolla, Mo. A. VERN KILPATRICK,
Missouri School of Mines and Metallurgy.

1000. Handy Desk for Log Sheets.

Figure 323 shows a handy desk fitted with a roll upon which log sheets can be placed while being made up, doing away with the numerous finger marks to which they are subjected in the engine room if laid out flat.

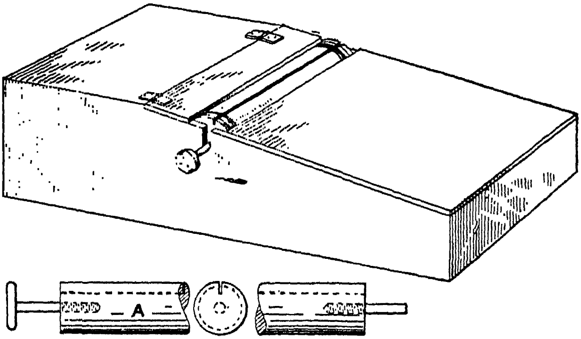


FIG. 323.—Desk and detail of log-sheet roll.

Roll *A* is made as long, plus ¼ in. on each end for margin, as the log sheet is wide. The diameter is the height of the log sheet, minus the margins on top and bottom, divided by 3.1416. It should be made of close-grained medium-hard wood. A $\frac{1}{16}$-in. saw slot deep enough to receive the margins of the log sheet should be made the full length of the roll. In placing the log sheet on the roll, the margins are inserted in this slot, and the sheet rolled hard against the wooden roll. Elastic bands ⅛-in. wide over each end and the middle will hold it in place.

Lag screws with the heads removed serve as the axis, or shaft. A wooden handwheel on the left serves to turn the roll. The slots in the desk *B* into which the shafts fit should be deep enough to allow the top of the roll to extend ¼ in. above the surface of the desk lid.

Keyport, N. J. GEORGE B. LONGSTREET.

1001. Stack Pressure.

A comparison of the results of the measurements on the slender power-plant stack with those made on a relatively short experimental stack shows that the wind pressure on a chimney at a given wind speed increases as the ratio of the height to the diameter. In the case of chimneys having an exposed height which does not exceed ten times the diameter, it is safe to assume that at a wind speed of 100 miles per hour the wind pressure is not greater than 20 lb. per square foot of projected area.

DEPARTMENT OF COMMERCE.

Commercial Standards Monthly.

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